

**THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)  
IN THE DEVELOPMENT OF EDUCATION IN NIGERIA: AN APPLICATION  
TO STATISTICS IN NIGERIAN HIGHER INSTITUTIONS**

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**Abstract**

The paper emphasizes the impact of Information and Communication technologies (ICT) for effective development of education in Nigeria. Worldwide research has shown that ICT can lead to improved student learning and better teaching methods. A report made by the National Institute of Multimedia Education in Japan, proved that an increase in student exposure to educational ICT through curriculum integration has a significant and positive impact on student achievement, especially in terms of "Knowledge comprehension, Practical skill and Presentation skill" in subject areas such as mathematics, science, and social studies. There are certain fundamental statistical concepts that are difficult for students to comprehend at an intuitive level. Teachers of statistics are continuously exploring new ideas and teaching practices to overcome such difficulties. This paper presents a broad overview of the role ICT can play in helping statistics students understand and reason about important statistical ideas. The main goal is to provide the introductory statistics lecturer/instructor who is considering using ICT in the statistics classroom as well as introductory statistics students with some background of some of the available resources in the field, where they can be found and how to effectively and efficiently utilize them to achieve his objectives. We also explain how recent changes in the teaching and learning of statistics are influenced by the increased use of ICT. However, ICT has an impact on education only if it is used appropriately. Therefore, the focus of this paper is on how ICT can best be used to improve student learning and how it can be used to support student learning. Two groups of 20 students each were selected and given an exercise on descriptive statistics to work using both the traditional (Manual) and Statistical package (ICT) based methods. The two results were compared in terms of speed (time of completion) and accuracy of results. The student's t-test and the Mann-Whitney U tests were used to test hypothesis of significant difference between the two methods for the two groups of students. Results obtained revealed a significant difference in the two methods for both the speed and accuracy of results obtained. It is therefore recommended that integrating ICT into education seems to be a necessary issue for educators and education administrators in Nigeria. However, if teachers cannot make good use of the ICT tools, the money and time spent on the ICT is going to be a waste. Also, if the educational budget is limited, looking for a cost-effective and high-performance ICT tool can be the first priority. Educational ICT tools are not for making educators master ICT skills themselves, but for making educators create a more effective learning environment via ICT.

**Keywords:** *ICT, Computer, Internet, Statistics, Teaching & Learning*

### **Background to the Study**

Education according to Denga (1993) in Onabamiro et al (2012) is broadly defined as “ongoing process that facilitates learning and acquisition of theoretical and practical skills that equip mankind to utilize the environment effectively for personal success in life as well as for the development of society”. He went further to explain that education is a process that focuses at the development of total person, his intellectual potentials, skills to increase his productive capacity, development of his character, his psychological adjustment and balance, his political and artistic value. He summarized by saying that education is a pot from which people can drink wisdom, knowledge, economic efficiency, morality, decency and functional skills which together can make them a credit to themselves and the their society.

ICT is an acronym that stands for Information and Communications Technology. However, apart from explaining the acronym, there is not a universally accepted definition of ICT? Why? Because the concepts, methods and applications involved in ICT are constantly evolving on an almost daily basis. It's difficult to keep up with the changes - they happen so fast (Riley, 2012). Information and Communications Technology or (ICT), is often used as an extended synonym for information technology (IT), but is a more specific term that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information. The phrase ICT had been used by academic researchers since the 1980s (William, 1986) but it became popular after it was used in a report to the UK government by Dennis Stevenson in 1997 (Kelly, 2000) and in the revised National Curriculum for England, Wales and Northern Ireland in 2000. The term ICT is now also used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system. There are large economic incentives (huge cost savings due to elimination of the telephone network) to merge the audio-visual, building management and telephone network with the computer network system using a single unified system of cabling, signal distribution and management.

So ICT is concerned with the storage, retrieval, manipulation, transmission or receipt of digital data. Importantly, it is also concerned with the way these different uses can work with each other. ICT is often categorized into two broad types of product: - (1) The traditional computer-based technologies (things you can typically do on a personal computer or using computers at home or at work); and (2) The more recent, and fast-growing range of digital communication technologies (which allow people and organizations to communicate and share information digitally). The technologies involved in communication tend to be complex. You certainly don't need to understand them for your ICT course. However, there are aspects of digital communications that you need to be aware of. These relate primarily to the types of network and the ways of connecting to the Internet. The development of electronic information and communication in the science and technology of radio, cassettes, tape recorders, television, video, telex and fax among others gives opportunity to millions of people to learn in an easier manner. The teacher can make use of any or a combination of two or more in the teaching-learning process i.e. (multimedia approach). Of recent, computers have revolutionized all areas of human endeavour Viz: education, transportation, communication business, to mention but a few. In education, it has industrialized learning. Learners learn through computer at their own pace and rate. ICT has brought about the integration of educational technology into the education pedagogy to enhance the production of quality teachers in Nigeria.

## **Background**

Statistics, or statistical methods as it is sometimes called, is playing an increasingly important role in nearly all phases of human endeavour. Formerly dealing only with the affairs of the state, spread to Agriculture, Biology, Business, Communications, Economics, Education, Electronics, Medicine, Political science, Psychology, and numerous other fields of science and Engineering. Statistics as a discipline has existed for many centuries. In colleges, Universities and in Polytechnics, it continues to be one of the subjects which are often considered to be difficult by students who try to avoid it. Statistical concepts are sometimes complex, abstract and involve laborious computations. But the way statistics is learnt and taught has undergone a paradigm shift since the advent of ICT. The advent of computers and related technology has changed the entire approach with which Statistics is being taught and learnt these days, of course there are some advantages and disadvantages associated with the increased usage of computers in teaching and learning of Statistics but overall its use has led to better understanding and handling of the discipline (Guru, 2008).

Teaching and learning of statistics has gained recognition in many disciplines over the past two decades. Statistics is integral part of the post secondary curriculum. In almost every discipline, the ability to understand, interpret and critically evaluate research findings is becoming essential skill. Microcomputers have an important role in modern statistics teaching (Garfield and Burril, 1997). They allow students to accomplish computational tasks more quickly, freeing them to focus more on statistical concepts. The computer is not only an efficient computational tool but can also help to clarify specific concepts by providing settings in which one can apply statistics techniques (Ben-Zvi, 2000; Biehler, 1997). The ICT revolution has had a great impact on the teaching of statistics, perhaps more so than many other disciplines. This is not so surprising given that technology has changed the way statisticians work and has therefore been changing what and how we teach (Moore et al, 1995). In the past decade, Internet evolved into the main communication media. The idea of e-learning also evolved and is developing very fast. Many universities and institutions around the world are offering distant learning courses and trainings, and the field of statistics is not an exception. The wealth of statistical resources on the web is enormous and is growing very fast. At the same time, many off-line systems for electronic textbooks evolved into the web supported course management systems. Such systems take communications advantages of the Internet in providing teaching material according to the paradigm of anytime and anywhere lifelong learning. Students have possibility to learn at their own pace and at the times that suit them best. Internet based e-learning systems enable tracking of students' activities, assessment and grading, student discussion forums and personal communications via e-mail. Widespread use of web based learning systems led to efforts to set up standards and recommendations for development of learning ware in order to establish Inter-operability of systems and re-usability of available information.

Since most educators have access to the www, statistics and lot of other statistics teaching and data analysis resources have provided an exciting new medium for teaching and learning. Internet proved to be an extremely efficient information delivery method, bridging physical gaps and barriers between users around the world. Many statistical systems are easily accessible and can be downloaded for educational use. While some parts of the world are keeping up with all described, there are other parts that are trying to catch up with the changes in the information society. The availability of Internet at home, the speed of connection and computer usage proficiency is much low in some transition countries in Eastern Europe, (SIBIS, 2003). The situation in some other parts of the world, in most of Asia, Africa and central and south Americas the situation is even worse.

### **Statement of the Problem**

Nigeria has embraced ICT as an instrument to enhance the quality of education, accessibility to learning resources, e.t.c. It is worthy of note that ICT infrastructure which include computer hardware and software, bandwidth, connectivity are grossly inadequate and have constituted constraints on its effective usage. This is further enhanced by associated physical infrastructure such as roads, electricity and so on. With respect to ICT, lack of reliable, widely distributed and high capacity data network including sound and video have contributed to the low availability and penetration of ICT services in Nigeria and Africa as a whole. Komolafe (2009) in Onabamiro et al (2012) observed that ICT infrastructures in higher institutions of learning in Nigeria are grossly inadequate. He contends further that much attention was paid only to internet while other essential equipments are lacking. About 65% of respondents in that study confirmed that computers available for internet are grossly inadequate to meet the demands of people for its usage.

### **Objectives of the study**

The aim of this paper is to emphasize the impact of Information and Communication technologies (ICT) for effective development of education in Nigeria. To achieve this aim, the following objectives are formulated:

1. To provide statistics lecturer/instructor who is considering using ICT in the statistics classroom as well as statistics students with some background of some of the available resources in the field, where they can be found and how to effectively and efficiently utilize them to achieve his objectives.
2. To compare the performance of students in statistics in problem solving by comparing the traditional and ICT based methods in terms of speed of ( time of completion) and accuracy of results

### **Research Hypothesis**

**The following hypotheses were tested for this study:**

1. There is no significant difference between the performance of students under the manual and ICT based methods in terms of speed (time of completion).
2. There is no significant difference between the performance of students under the manual and ICT based methods in terms of accuracy of results obtained.

### **ICT in Education**

ICT tools are useful in teaching basic skills. Computer Aided Instruction (CAI) helps students to learn at their own pace through the drill practices and tutorials. The use of ICT in Education is on the increase. Thus there is e-learning in the classrooms and students now learn more on the internet. Courses from far away institutions are now taken on-line. A growing number of teachers are using computer graphics and other digital media to convey information in a more dynamic form to students. Again, teachers use computers and multimedia technology to create in-class presentations using power point. To get students more involved in the learning process, many teachers use hypermedia and interactive multimedia software that put students in control of the classroom as against teacher controlled media presentations, which are considered passive. In distance education, Computers, the internet and other communication technologies offer many promising possibilities in education. Computers are also widely used in Students Management Information Systems.

### **Impact of ICT on Statistics Course Content and Specifications**

While the impact of ICT on the practice of statistics is irrefutable, just as powerful has been the impact of ICT on statistics curriculum, course specifications and recommended practices. It is hard to imagine

teaching statistics today without using some form of ICT. However, just twenty (20) years ago that was very common. Today's statistics classes may be taught in a classroom with a computer connected to a projector for easy follow up or may take place in a laboratory with students working on separate computers. Others may use a portable computer (laptop) at school, home and on the move. An ever growing format of teaching today is over the Internet, in the form of a web-based course with video-taped lectures, interactive discussions, collaborative projects, and electronic text and assessment materials. These have led to many changes in higher institutions of learning course specifications in statistics. For example in Nigerian polytechnics, National board for technical education (NBTE) reviewed the statistics curriculum in 1990 and 2004. The new curriculum has been structured in unit courses in line with the provisions of the national policy on education (NPE) which makes it mandatory for all institutions to introduce the credit unit system that allows for transfer of courses completed in one institution to another similar or higher institution. Also, the content of each course has been spelt out in behavioural objectives to enhance the articulation process if the transfer of credits between institutions is to be meaningful and acceptable to all institutions and for employers to know the behaviour of diplomates of the programme seeking entry level employment in industry.

Among the goals and objectives of the statistics programmes in the polytechnics as outlined in the revised NBTE curriculum (2004) include:

1. A deep understanding of statistics and application within the commercial, industrial, and scientific environment.
  2. Practical skills in research methodology, analysis and design of experiments leading to decision making and/or prediction.
  3. Ability to use a computer when the need arises
- Also, among the list of other physical requirements for the programmes include 10 micro computers and at least 3 statistical packages for National Diploma programme and 15 micro computers and at least 5 statistical packages for the Higher National Diploma programme.

### **ICT Tools For the Teaching of statistics**

The types of tools used in statistics instruction can be broken into several categories. There is much overlap in the capabilities of the tools across these categories, yet no one tool seemingly covers all possible educational uses. (Ben-Zvi 2000; Biehler 1997). We provide here a brief summary of the types of tools available and some of their benefits and disadvantages highlighting some of the more common examples of each type of tool.

Beth Chance et al (2007) provide among others the following categories:

#### **1. Statistical Software Packages**

Statistical packages are software designed for the explicit purpose of performing statistical analyses. Several packages have been used by statisticians for many years, including SPSS (<http://www.spss.com>), S-plus (<http://www.insightful.com>), R (<http://www.r-project.org>), SAS (<http://www.sas.com>), and Minitab (<http://www.minitab.com>). While development of these packages has focused on uses by industry, they have also evolved into more menu-driven packages that are more user friendly for students. The term menu-driven is used to describe a software program that is operated using file menus instead of commands. Menu-driven is commonly easier for most users as it allows the user to navigate using the mouse. As these packages become more user friendly, they are being increasingly used in introductory courses.

The statistical package Minitab in particular has always had a pedagogical focus and is becoming increasingly feasible as a tool that allows student exploration and construction of ideas. Data Desk (<http://www.datadesk.com>) is a similar package but has focused on data exploration and interactive graphics from its initial development. R (Verzani 2005) is a language and environment for statistical computing and graphics that provides a wide variety of statistical and graphical techniques, including linear and nonlinear modeling, statistical tests, time series analysis, classification, and clustering. It is freely accessible and is being increasingly used in introductory statistics classes. Additional add-ons can be downloaded to improve the graphical interface of the program (<http://socserv.mcmaster.ca/jfox/Misc/Rcmdr>). More cost effective alternatives to these packages include student versions which are smaller in scope (does not work for as large of data sets) and several stand alone statistical packages are also now available for free or at minimal cost, online. For example, Stat crunch; <http://www.statcrunch.com>), is a fully functional, very inexpensive, Web-based statistical package with an easy-to-use interface and basic statistical routines suited for educational needs.

## **2. Educational Software**

Different kinds of statistical software programs have been developed exclusively for helping students learn statistics. Fathom (<http://www.keypress.com/x5656.xml>), a flexible and dynamic tool was designed with the input of many statistics educators and educational researchers to help students understand abstract concepts and processes in statistics, and does not attempt to have the capabilities of more traditional statistical software tools. Erickson (2002) described Fathom as a dynamic computer learning environment for teaching data analysis and statistics based on dragging, visualization, simulation, and networked collaboration. The strongest features of Fathom are the easy access to multiple, linked representations, including sliders, the ability to build and run simulations, and the many different ways of importing data from a variety of sources. One small example of the very dynamic, interactive features of Fathom is pointing on the edge of a histogram bar and dragging the bar, which immediately updates the graph

Inspire Data (<http://www.inspiration.com/productinfo/inspiredata>) is a commercial extended version of Table Top that also focuses on visual representations in helping students “discover meaning as they collect and explore data in a dynamic inquiry process.” This package also offers linked representations, animations, and easier annotation of data analyses and presentations. Some of these educational packages are also making it easier for students to access large data sets (e.g., Census data) and for teachers to access pre-developed classroom exercises. The limited statistical capabilities may prevent their use beyond an introductory course (though they are expanding, e.g., Fathom now offers multiple regression), but has benefits in being less overwhelming to the students and being more geared to the point-and-click generation.

## **3. Spreadsheets**

Spreadsheets such as Ms Excel (<http://office.microsoft.com/>), Lotus 123, are widely available on many personal computers. However, care must be exercised in using Ms Excel as a statistical educational package. Ms Excel does have some strength in helping students learn to organize data and in “automatic updating” of calculations and graphs as values are changed, and some advocate Ms Excel due to its widespread use in industry and relatively easy access.

#### **4. Applets/Stand-alone Applications**

Over the last decade there has been extraordinary growth in the development of on-line applets that can help students explore concepts in a visual, interactive and dynamic environment. An applet is a software component that usually performs a narrow function and runs typically in a Web browser. Many of the applets are easy for students to use and often capture an interesting “context” for students. In addition, a large number of computer programs can be downloaded from the Internet and run without an Internet connection that allow students to explore a particular concept (e.g., Sampling SIM allows the student to explore the nature of sampling distributions of sample means and sample proportions, freely downloadable from: [http://www.tc.umn.edu/~delma001/stat\\_tools/software.htm](http://www.tc.umn.edu/~delma001/stat_tools/software.htm)).

**5. Multimedia Materials:** These materials often seek to combine several different types of technology. For example, ActivStats (<http://www.activstats.com>) has been used in college classrooms, combining videos of real world uses of statistics, mini-lectures accompanied by animation, links to applet-like tools, and the ability to instantly launch a statistical software package and analyze a data set. An advantage of such an environment is that students only need to learn one type of technology. In fact, more and more, entire lessons and even textbooks are written around these types of embedded technology to make them a “living” textbook, e.g., Cyber Stats (<http://www.cyberk.com>; ). Many other multimedia resources are currently being developed around the world. While these tools are too numerous to list here, the Consortium for the Advancement of Undergraduate Statistics Education (CAUSE, <http://www.causeweb.org>) provides a peer reviewed annotated list of such tools. What these tools often gain in visualization and interactivity, they may sometimes lose in portability. And while they can be freely and easily found on the Web, they are not often accompanied by detailed documentation and activities to guide student use. The time required for the instructor to learn a particular applet/application, determine how to best focus on the statistical concepts desired, and develop detailed instructions and feedback for the students may not be as worthwhile as initially believed.

Internet provides a lot of material useful for teachers and students and this is a growing phenomenon. The most useful resources are data tables, textbooks, electronic journals, applets and free soft ware's. There are subsequently an increasing number of sites giving lists of links, frequently maintained by academic researchers. The international association for statistical computing (IASC) web site (<http://www.stat.unipg.it/iasc/>) is among the best websites maintained by association or consortiums where one can easily have access to a wide range of links. Another interesting entry point is the CTI-Stats, which is a part of a wide project between British universities for developing the use of computers in education (<http://www.stats.gla.ac.uk/cti/>). Some private companies provide useful links to software, data-base and other material, for instance STATSNET (<http://www.statsnet.net/>). However the most comprehensive sites are maintained by individual researchers:

M. Friendly from York University (<http://www.math.yorku.ca/SCS/StatResource.html>) gives very complete information and J. Puranen (<http://noppa5.pc.helsinki.fi/links.html>) has one of the most complete lists of links for teaching material. D. Stockburger provides in his electronic textbook about Multivariate Analysis some list of links (<http://www.psychstat.smsu.edu/scripts/dws148f/statisticsresourcesmain.asp>) with short comments. The many types of tools and resources listed above offer great choices for instructors, as well as decisions about how to best use these tools, how often to use them, and for what purposes and activities. While many of the tools described are bona fide research tools, others have been developed primarily for learning purposes.

### **Issues to Consider when selecting ICT tools in a Statistics Class**

Despite some of the obstacles, it is still important to try to find ways to access and utilize appropriate ICT tools to help students learn statistics. The GAISE College Report lists some issues to consider when selecting computer tools to use in helping students learn statistics:

- i. Ease of data entry and ability to import data in multiple formats
- ii. Interactive capabilities
- iii. Dynamic linking between data, graphical, and numerical analyses
- iv. Ease of use for particular audiences
- v. Availability to students and portability

We believe that no one tool can do it all and that there are many good tools available to use, many of which are free. Therefore, rather than thinking about one ICT tool for students to use, we encourage teachers to think about what sets of tools will help students best learn statistics in each unit of the course.

### **Data and Methodology**

The data used for this study was primary data on the performance of two sets of students consisting of 20 in each group. Each of the two groups was given a statistics problem to solve using both the traditional (manual) and ICT based (statistical software MINITAB) package. The speed (time of completion) and accuracy of results for each of the 20 students in each of the two groups were recorded. The results were compared using a parametric technique: test for difference between means (student's t- test) and a non-parametric test: the Mann-Whitney U test.

### **Results and Analysis**

The two sets of results were compared as stated above by the use of a statistical software package Minitab for windows version 16. The student's t-test was performed at 5% level of significance. For the first group of students the t- value was 13.00 and the P-Value was 0.000. For the second group of students, the t-value was 10.50 while a p-value of 2.67 was obtained which led to the rejection of both hypotheses. On that basis, it was concluded that there was significant difference between the performance of students under the manual and ICT based methods in terms of both the speed (time of completion) and accuracy of results obtained. For the Mann whitney U test, both results were also rejected at the 5% level of significance which led to the conclusion that there was significant difference between the performance of students under the manual and ICT based methods in terms of both the speed (time of completion) and accuracy of results obtained.

### **Conclusion**

ICT has been and will continue to be a major factor in improving students learning of statistics. However, effective utilization of ICT requires thoughtful and deliberate planning as well as creativity and enthusiasm. Despite the endless capabilities that ICT offers, instructors should be careful about using sophisticated software packages that may result in the students spending more time learning to use the software than applying it. Even in the advanced technological society, some students are not always ready for the type of tools used in courses. Choice of a particular ICT tool should be made based on ease of use, interactivity, dynamic linkages between data/graphs/analyses, and portability. Good choices if used appropriately can enhance student collaboration and student-instructor interactions, and often a combination of several different tools will be necessary.

Nowadays, we can see increased availability of computers, access to the Internet, updated and more widely available software, often via CDs bundled with textbooks or on the World Wide Web. Methodological changes in the teaching of some subjects such as Statistics in experimental degrees are a necessity and a



challenge for academic staff. Without losing course content and importance, the introduction of ICT to the classroom, in a bid to involve less theory and more practical work, allows the student to understand and assimilate the contents of the subject in a more efficient way.

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