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PRIMARY MATHEMATICS AND INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

U.N.V. AGWAGAH
Department of Science Education, University of Nigeria, Nsukka, Nigeria

ABSTRACT

This paper discusses the meaning of ICT, the relevance of mathematics to ICT, and vice versa. It provides some specific examples of activities and primary mathematics concepts/topics for which ICT can support teaching and motivate learning. The paper also reports on the implementation of ICT in primary school mathematics in Nigeria. It goes further to suggest some barriers to successful use of ICT in primary mathematics.

INTRODUCTION

The world is globally going through information and communication technology revolution. According to Hagenaars (2000), ICT was the backbone of an era called the information age which commenced during the latter half of the twentieth century. During this era, the dominant information technology became the radio, television, and print, especially in developing countries such as Nigeria.

Today, new areas of ICT are emerging, such as the calculator, the computer etc., and its development is changing both at home and in the wider society. For instance, in the past, when you visited the homes of friends who had computers, their computers would be tucked away in some remote and infrequently visited corner in the house- the "computer room". Going to the computer room usually by oneself meant leaving the family centre of activity. Recently, there are some significant changes. Computers have now taken over the dining room, kitchen, etc in some homes. Also in the past families would gather after dinner to play the game of Ludo, Scrabble, Whot or Chess. Some families still do. But, evidently, the computer is playing an increasingly strong role in family entertainment and learning. Some families now have more than one computer so that increasing pressure for family use would not tie up the machine. Thus, the impact of ICT on the lives of individual continues to grow. It is essential therefore, that every individual takes advantage of its opportunities and to understand its effect. It is also important that individuals gain the appropriate skills, knowledge and understanding to have the confidence and capacity to use ICT throughout their lives.

Familiarity with ICT is being regarded now as a new literacy, as essential to a country's social and economic development as the established literacies of reading,

writing and numeracy. Sanders (1986) defined literacy as the ability to manipulate the current information technology. Thus, there is need to provide everybody, especially the youths, with the opportunity to acquire and develop the skills needed to participate in the information society. According to Ajayi(2002), the National Co-ordinator and Director of ICT, Nigeria has about 48% of the population to be youths under the age of 15 years (primary school pupils belong to this group).The future of these youths depends on their early exposure to ICT, and the information society in all its ramifications. Hence, adequate plans and strategies must be fashioned out for this group in their exposure to ICT.

The developments in the availability of ICT have led to a major re-evaluation of various school curricula, especially school mathematics curricula, in terms of contents and strategies for teaching and learning mathematics (Victorian Curriculum and Assessment Authority, 2002). This places emphasis upon the use of technology in concept development, as well as in technology-assisted approaches to problem solving, modeling and investigative activities. The critical question concerning the ICT in Nigeria is "What place does it have in the mathematics classroom, especially the primary mathematics classroom? Is ICT of any relevance to mathematics and vice versa? What is the trend in ICT usage in our primary schools?" What is the policy statement on ICT in primary schools These, among others, are the issues addressed in this paper. The paper is organized as follows:

- The National Policy on Education and ICT in Primary Schools.
- Meaning of ICT.
- Relevance of Mathematics to ICT
- Relevance of ICT to Primary Mathematics.
- Some examples of Primary mathematics concepts and activities for which ICT can support teaching and motivate children's learning.
- Implementation of ICT in Primary School Mathematics.
- Barriers to successful use of ICT in Primary Mathematics.
- The Way Forward.

THE NATIONAL POLICY ON EDUCATION AND ICT IN PRIMARY SCHOOLS

Primary education, as referred to in the Nigerian National Policy on Education, "is the education given in institutions for children aged 6 to 11 plus"(F.R.N., 2004:14). It is the key to the success or failure of the whole educational system. The goals of primary education include: the inculcation of permanent literacy and numeracy, and ability to communicate effectively; laying a sound basis for scientific and reflective thinking; and

developing in the child the ability to adapt to the child's changing environment. These objectives are well structured, but the issue is how can children be guided towards achieving the noble objectives?

One of the facilities for helping children to achieve these objectives is the Information and Communication Technology (ICT). In developed countries, such as the United States, ICT has since been integrated in the mathematics curricular at all levels of education. (Rogerson, 1992). The recommendation was made in the 1980s in the Agenda for Action that mathematics courses should take full advantage of the power of calculators and computers at all grade levels (NCTM, 1980). Also in England, there is the government framework for teaching mathematics, using calculators and computers for all primary schools (Fox, Montague-Smith and Wilkers, 2000).

In the developing countries such as Nigeria, policy frameworks are also in place concerning the integration of ICT into education. For instance, the National Policy on Education (F.R.N., 2004:17), states that:

> In recognition of the prominent role of information and communication technology in advancing knowledge and skills necessary for effective functioning in the modern world, there is urgent need to integrate information and communication technology into education in Nigeria.

The question is has ICT actually been integrated into primary mathematics education in Nigeria? Are the primary school teachers properly informed about the ICT to be able to integrate it into their teaching of primary mathematics?

MEANING OF INFORMATION AND COMMUNICATION TECHNOLOGY

'Information' refers to facts or details that tell you something about a situation, person, event, etc. According to the Oxford Advanced Learner's Dictionary, 'Information' is defined as news or knowledge given. The process of giving the news or knowledge is Communication.

In its former meaning, technology, on the other hand, is an ensemble of devices

and procedures based on science, and directed towards a practical result (Borgmann, 2003). It is the application of scientific knowledge, skills, work attribute, tools and equipment to the evaluation of new processes in the production of goods and services for the benefits of mankind.

Information and Communication Technology (ICT), or Information Technology (IT) therefore, may be viewed as any equipment that provides the storage, processing, retrieval, transmission and display of information and which allows users to communicate and manipulate information electronically (Sanders, 1981; ESCAP, 2001).

ICT has been classified into traditional services such as radio, television, etc., and new technology which consists of calculators, computers and specific data processing applications accessible through those computers, such as, e-mail, internet, word processing, cellular phones, wireless technologies, etc. (Marcelle, 2000).

A calculator is a computing device. It calculates and does it quickly and accurately (Blakeley, 1985). A computer on the other hand is a machine designed for the input, storage, processing and retrieval of information. It accepts data (information) as (INPUT), stores them as (STORAGE), processes them as (PROCESS) according to precise/logical instructions as (PROGRAMS), to produce a fast, accurate and efficient result as a new information as its (OUTPUT).

The Microsoft Encarta Premium Suit (2004), defined a computer as an electronic device that can receive a set of instructions or program and then carry out this program by performing calculations on numerical data or by manipulating other forms of information. Essentially, a computer performs three basic operations as follows:

(i) It accepts data (input)
(ii) It processes data (processing)
(iii) It gives output or result (output)

In this paper, ICT refers to calculators and computers in primary mathematics education. Mathematics is said to be the pivot of all scientific and technological development. If that is the case, what is the relevance of mathematics to ICT? Eguavon (2002), writing about the relevance of mathematics to ICT stated that mathematics is the heart beat of ICT. However, he did not provide further information on how mathematics is the heartbeat of ICT; no examples of specific mathematics concepts and their applications in ICT. There is need to have information on specific application of mathematics to ICT.

RELEVANCE OF MATHEMATICS TO ICT

Blakeley, (1985), pointed out that the advent of calculators and computers strikes at the heart of mathematics. The subject matter of mathematics is intimately related to the operation of a computer. Although the roots of the computer date back to the geared calculators of Pascal and Leibniz in the 17th century, it was Charles Babbage in the 19th century who designed a machine that could automatically perform computations based on programme of instruction stored on cards or tape. Babbage's imagination outran the technology of his days, and it was not until the invention of the relay, then of the vacuum tube, and then of the transistor, that large scale, programmed computation became feasible. This development has given great impetus to areas of mathematics such as numerical analysis and finite mathematics.

A great deal of mathematical research led to the invention of the programmable digital computer. In manipulating information, the digital computer translates the information into a specific form that it can understand. This form is the digital or binary code. Thus, all letters, numbers, and characters, pictures, parts of pictures, sounds, etc are translated from their print equipment into digital or binary codes (Sanders, 1986). Digital or binary codes use voltage patterns that the computer can store in its circuits, retrieve and manipulate, and are usually represented conceptually in combinatios of ones and zeros (e.g. 101101). Thus, the operation of ICT is based on the application of binary system of numbers. The advantage of the binary system (base 2), is that the only symbols used (0 and 1), can be represented in a computer by a current being on or off, or by a memory location being occupied or unoccupied.

In processing information computers translate the information from the user into binary numbers in a process called digital encoding. Letters can be encoded by replacing every letter with its numerical position (1-26) in the alphabet and then converting these decimal numbers into binary equivalents. A sound can be encoded as a series of numbers that measure its pitch and volume at each instant in time. An image can be encoded in a sequence of numbers that represent the colour and brightness of each portion of the picture. The computer is able to decode information by converting the numbers back into letters, sound, or images.

Under definite very wide assumptions, one may disregard the quantitative peculiarities of information and express its amount by a number. This number only describes the possibility of transmitting information over a communication channel and of storing it in machines with a memory. These cannot be done if mathematical knowledge is not in place. In fact, examples abound on the application of mathematics in

ICT.

1. Computer makes use of mathematical signs and symbols for its functional operations;
2. The equality x = y provides information about the relation between the variables x and y.
3. Results of measurements of some physical quantity performed within certain errors provide information on its exact value. By increasing the number of observations one changes this information; and
4. The measure of dependency between two random variables x and y defined as a function of the amount of information in one random variable with respect to the other is given by $R(x,y) = [1 - e^{-21\,(x,y)}]\ ½$, where R(x, y) is the information correlation coefficient, and 1(x, y) is the amount of information. So also, the criteria relevant to the "exactness of reproducibility of information" ("a measure of the quantity of information transmission from an information source to a receiver over a communication channel"), in the theory of information transmission are usually treated statistically.

RELEVANCE OF ICT TO PRIMARY MATHEMATICS

Kaput (1992:515), described the role of technology in mathematics education as "a newly active volcano - the mathematics mountain... changing before our eyes, with myriad forces operating on it and within it simultaneously".

According to Becta (2005), the calculator is a powerful and efficient tool which allows children of primary age to make use of real data often numbers with several digits that they have gathered in their research or experiments, perhaps to work out a percentage, or to compare totals or proportions. He stated further that in the primary years, the calculators main role in mathematics lessons is not as a calculating tool since children are still developing the mental calculation skills and written methods that they will need throughout their lives. The calculator offers a unique way of learning about numbers and the number system, place value, properties of numbers, and fractions and decimals. For instance, the teacher could use an overhead projector calculator for whole class demonstration purposes so that the class can predict what happens when they multiply a number by 10 or divide by 10.

The technical skills required in using a calculator include: the order in which to use the keys, how to enter numbers such as sums of money, measurements, or fractions, how to interpret the display, how to use the memory, etc.an ability with single digit

arithmetic, the understanding of place value, etc (Reys, 1989).

The computer, on the other hand, makes it possible to experiment in mathematics, to investigate properties and behaviours of mathematics-objects, to visualize, to facilitate the formulation and testing of hypotheses and conjecture, in addition to being an essential tool in dealing with mathematics models (Rogerson, 1992).

Cannings and Brown (Eds) (1986) stated that the computer can be used as a tutor. This involves using computer as a teaching machine. Lessons are programmed into the computer either on the hard disk or in a diskette or compact disk to be used by the teacher in teaching new material, and then providing drill and practice on that material. The computer can also be used as a tool. The teacher can use it as an instructional material to demonstrate or illustrate a learning experience.

Thus, generally in primary mathematics, ICT can enhance teaching and learning by enabling pupils to:

1. Explore, describe and explain numbers, patterns, e.g. by watching a counting 'meter' with sequences of numbers shown slowly one at a time or experimenting with patterns of multiples highlighted on different number grids.;
2. Practice and consolidate their number skills, e.g. by using software designed to 'teach' or practice a particular skill and give rapid assessment feedback to the teacher and the pupils.
3. Explore and explain patterns in data, e.g. by accessing, displaying and interpreting ready made data, displaying quickly a bar chart or pictogram showing the outcome of a class vote, or using a sensor connected to a computer, to measure, display, and show trends in room temperature.;
4. Estimate and compare measures of length or distance, angle, time, etc, e.g. by devising a sequence of instructions to move a floor robot or screen 'turtle' along a path, then modifying their instructions in the light of the robot's response.
5. Experiment with and discuss properties of patterns in shape and space, e.g. by using software to transform shapes and create geometric patterns, or watching a film of a square being halved in different ways.
6. Develop their mathematical vocabulary, logical thinking and problem solving skills, e.g. by using a "branching tree" computer programme to sort shapes or numbers or exploring a simple simulation to discover the mathematical relationship that underpins it. Also, as pointed out by Victorian Curriculum and Assessment Authority (VCAA) (2002), pupils are able to use ICT to obtain

diagrams, graphs, tables, and other data to be used in subsequent mathematical activity, e.g. in the measurement strand.

The essential skills that ICT help to develop in children include: communication skills, numeracy skills, self management and competitive skills, social and cooperative skills, physical skills and work and study skills.

SOME EXAMPLES OF PRIMARY MATHEMATICS CONCEPTS AND ACTIVITIES FOR WHICH ICT CAN SUPPORT TEACHING AND MOTIVATE CHILDREN'S LEARNING

Reys (1989) provided some activities illustrating ways, in which calculator use can help primary school pupils to have conceptual understanding, explore problem solving strategies and generate data. For instance, supposing a mathematics objective for the day's lesson, in primary 5, is to introduce the concept of mean. In the past, pupils would spend a considerable amount of time with paper and pencil adding lists of numbers and then dividing to find the mean. The amount of time and energy expended on the calculation would distract attention from the objective. However, with the calculator, all the computation can be performed on it, and the pupils can concentrate on the concept rather than the tedious computation. This provides the teacher addition time needed to bring meaning to the concept and helps to sustain pupils' interest in the concept. Thus, with the calculator, attention is focused on understanding the concept of mean rather than simply computing the mean.

Another activity is the game of TARGET. This can be used in the senior primary classes to help pupils understand what happens when a number is multiplied by a number near 1 (greater than or less than 1).

Title of Activity: Exploring Factors Near 1

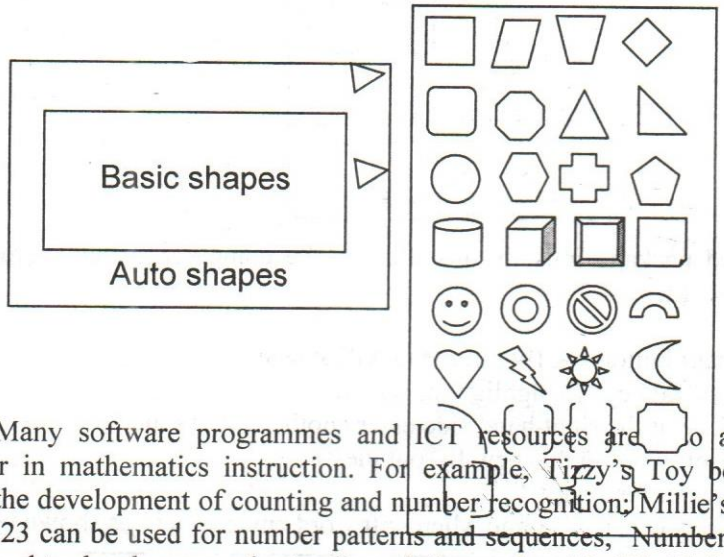
Class: Senior Primary

Materials: calculator, preferably an overhead calculator or pupils can use their calculators. **Procedure:** Pupils are given a target range of numbers say 1000 - 1100, and a start value say 26. If one calculator is used the teacher enters the start value 26 into the calculator, presses x and asks for a volunteer to estimate a factor that when multiplied by 26 will produce a product within the target range. Eg. Try 45... 26 x 45 = 1170 just over the target range. Pupils now work with the new display 1170. They find the number which can be multiplied by 1170 to produce a product (display) in the target range. Eg. Try 0.8... 1170 x 0.8 = 936, just below

In the Microsoft word environment look very well for Auto shapes at the right-hand side button of the screen. The following steps are taken to complete the procedure:

1. Click on the icon at the right-hand side of Auto shapes - there will be a first fly-out menu.
2. Use the upwards direction key ( ) to highlight the Basic shapes.
3. Use the right direction key ( ) to go into the second fly-out menu
4. Click on any of the basic shapes you want.
5. Go to the printable page area and display the diagram.

NB: To display the diagram, press down the clicking button and drag downwards to the right-hand side of the screen. The diagram below depicts the procedure above.



Many software programmes and ICT resources are also available for using computer in mathematics instruction. For example, Tizzy's Toy box can be used to support the development of counting and number recognition; Millie's MATH house-My World–123 can be used for number patterns and sequences; Numbers Shark-Sum More can be used to develop an understanding of place value; My World for shape recognition and manipulation (e.g. tessellation) activities; etc

IMPLEMENTATION OF ICT IN PRIMARY SCHOOL MATHEMATICS

ICT has been implemented in many nations' schools such as the United States (NCTM, 1987), United kingdom (Mathews, 1992), and other countries such as Greece, Egypt, India, Arab States (Rogerson, 1992). What is the extent of implementation of ICT in Nigerian Primary Schools especially in mathematics?

The implementation of ICT in schools can be seen as a continuum beginning with conviction of the effects of ICT on achievement and interest or attitude, progressing through access to ICT, teachers and teaching method, curriculum issue and ending with the full integration of ICT into teaching and learning.

EFFECTS OF ICT ON ACHIEVEMENT AND INTEREST/ATTITUDE

Although it is agreed that ICT plays a positive role in the educational process, the links between educational development and the use of ICT is yet to be clearly established and supported by empirical results from Africa (Thioune, 2003). According to him, there is a blatant lack of empirical data (mainly quantitative information) to verify this link.

However, a considerable amount of research has supported the view that, the use of ICT in schools enhances students' learning attitudes and behaviours, but there is little conclusive evidence of improved learner's achievement through the use of ICT, especially with primary school pupils.

ACCESS TO ICT

Although the Western countries have generally welcomed the advent of electronic calculators and computer, and therefore provided the new technology, in schools, even primary schools, this has not happened in Africa, (Wilson, 1992). For instance, in the United States in 1985, only 15 percent of elementary schools were without computers. Most elementary schools had at least five computers, and in fact 5,700 schools had fifteen or more (Meserve and Suydam, 1992), and mathematics has been the predominant subject in which computers are used (Becker, 1985). In the United Kingdom, only a few primary schools are today without at least one microcomputer and many children have their own hand-held calculators (Mathews, 1992). Over ten years after Wilson's 1992 report, what is the situation in Nigeria?

It has been reported that majority of primary schools do not have computers. Computers are mainly available in schools in urban areas and private schools, but not in rural areas and public schools. One obvious reason why calculators and computers are not

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available in schools is economic. These cannot be provided to schools by a Ministry of Education or government which is having difficulty in paying the salaries of teachers and supplying the schools with enough instructional materials, including textbook. Another obstacle could be attitudinal. Stake holders in school have shown an extraordinary resistance to 'allowing' calculators to be used in schools particularly at primary level. Even school leavers have never been permitted to write examinations using calculator in examinations such as the University Matriculation Examination (UME). However, this was allowed, for the first time, this year 2006. (JAMB, 2006). **Teachers and Teaching Methods**: It has been reported that many teachers feel worried about integrating ICT into their lessons. Their reasons could be that they are unsure about their role, as most of them are not computer literate. Hence, attention must be paid to the training of teachers on the use of computers in primary school mathematics.

CURRICULUMISSUES

The primary mathematics curriculum needs to be redesigned to meet the challenges of the new technology. According to Crown (1995-2005), ICT at primary level should basically cover the following five main areas: learning from feedback, observing patterns, exploring data, teaching the computer (through pupil-designed activities), and developing visual imagery. ICT-assisted instruction should also be evaluated with ICT in addition to paper and pencil evaluation.

BARRIERS TO SUCCESSFUL USE OF ICT IN PRIMARY MATHEMATICS IN NIGERIA

The barriers to the use of ICT in Nigerian primary schools include:

1. Lack of qualified teachers to handle the programme. Many primary school teachers lack the skills and confidence in using the computer.
2. Lack of other qualified personnel such as technicians, computer operators, etc.This is the issue of technical expertise.
3. Lack of access to ICT facilities by both teachers and pupils. Many schools do not have computers, and the economic problem in the country does not give teachers and parents the opportunity to own computers.
4. Inadequate power supply. It is not possible to use the computer for instruction in a country where power supply is epileptic. The fluctuations might damage the computers, cause equipment malfunctions and destroy data. However, this can be taken care of by the use of UPS.
5. Possible nonchalant attitude by school administrators to organize ICT for effective

use. Many school administrators are also not knowledgeable in the use of computer, and hence cannot organize computer programmes in their schools.
6. Non availability of high quality software that correlates with curriculum.

THE WAY FORWARD

There is no doubt that ICT is compelling certain changes in our lives and ideas. Thus, there is need to provide everybody with the opportunity to acquire and develop the skills needed to participate in the information society. There is need to integrate the ICT in the schools curriculum, especially the mathematics curriculum. There is need also to introduce the ICT to the primary school level. It is important to "catch them young". However, there are a lot of barriers to successful use of ICT in primary mathematics. The following therefore are suggested as the way forward:

1. Government and Ministries of Education should ensure that calculators and computers are made available in primary schools for mathematics lessons.
2. Teachers and pupils should have access to ICT facilities.
3. Teachers need to receive adequate training through workshops, in-service courses, seminars, etc. to be able to effectively cope with the integration of ICT into primary mathematics.
5. Adequate power supply or alternative source of power should be provided in areas where there is none.
6. School administrators should receive professional development to keep them well informed on the use of ICT for proper organization/management of ICT in schools.

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