

## Learning Strategies in Teaching Science through Information and Communication Technology (ICT)

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### Abstract

The major objectives of education is to bring about desirable change in behavior in individual and the society at large, which can be enhanced by active learning. This paper examines the use of active learning in science through Information and Communication Technology (ICT). Active learning was considered as anything that student do in classrooms other than merely passively listening to the teacher. It identify active learning strategies as stated by Osisoma (2005) to include cooperative learning and small group activity, individualized activities immediate feedback and critical thinking motivator. ICT facilities accessible to active learning strategies were identified as E- Portal, Mesh network, ICT – based distant teaching and learning school net project, ICT mobile classroom among others. Various modes through which these facilities can be used were identified. The implications of these ICT facilities usages in active learning were stated. It was recommended that government should encourage ICT resource inflow for active learning by creating enabling environment that will enhance access of all students, and public institutions.

**Keywords:** *Learning, Strategies, Teaching, Science, Information and Communication Technology*

### **Background to the Study**

Education, at the end of the 20<sup>th</sup> century no longer prepares for secure, life-long employment in local industries or services. Rather education is for individual and national development, critical to which is science, Technology and Mathematics Education. According to Babay (2006), the major objectives of education is to bring about desirable change in behavior in individuals who undergo educational training. Adelaja, (2007) stated that, the latest World Economic Forum on Global Information Technology (WEFGIT) report revealed that, Nigeria is 10<sup>th</sup> in the Development and application of information technology in Africa and 88<sup>th</sup> in the world. And that, new ICT related tools can make institutions more productive, enhance skills and learning.

Akudolu (2002) maintained that education should serve as an instrument for social stability, economic sufficiency and cultural integration if effectively provided. Effective education can be achieved through active teaching and learning with adequate relevant and effective instructional materials like the information and communication technology (ICT) facilities.

Osioma (2005), stated that research has shown that students learn meaningfully when they are actively involved in the learning process. This is more so when they work in small groups and have the opportunity to negotiate meaning and construct conceptual understanding in a community of learners thereby making education more relevant.

In support of this Jajua (2006) opined that one of the recent drives of the society towards making education relevant is making information and communication technology (ICT) a common feature of the educational process. Information and communication technology is that process of utilizing information and data dissemination through electronic facilities such as the computers, videos, Radios and Phones. The modern society uses this medium to share knowledge, ideas, information and data in limited dimensions consequently, education is facilitated and learning learn to their individuals pace.

A researched into a study of typical activities taking place in the computerized classroom environment (Zandvliet, David, Fraser, & Barry; 2005), showed a high level of student involvement in other activities besides learning. It showed that overall students spent most of their time interacting directly with the computer with the task of browsing on-screen and entering data together accounting for entering data together accounting for nearly 50% of the total time spent in class. This study further conveys that the computerized learning environment fosters independent study and limited teacher dominance in lesson control and learning processes. In a similar study, Sharma (2005), observed that 'the of ICT in education and the role of the teacher in using that technology are pertinent in shaping the future of education'. This is because the information and communication technology process are used in promoting the globalization and internalization of knowledge, data and skills from which education can benefit substantially.

In another similar connection, Kwache (2007), stated that “in concrete terms ICT enhances teaching and learning through its dynamic” interactive, flexible and engaging content. It provides real opportunity for individualized instruction, accelerates, enriches and deepen skills, and engage students actively in learning”. These agrees with Lee

(2001), who opined that as science requires direct interaction with nature, science teaching can be enriched, be made more effective and maximized using ICT tools effectively. Despite these recognized roles of ICTs in improving not only quality and quantity of education, ICTs remain a low policy or financial priority in our educational system. It is against this that the paper attempts to evolve some teaching and learning strategies using the ICT for the effective teaching of science, technology and mathematics for sustainable development of Nigeria.

### **Active Learning**

Active learning is the teaching and learning that shifts the focus from the teacher and delivery of course content to the student and active engagement with the material. According to Mayer (2004), active learning is an umbrella term that refers to several models of instruction that focus the responsibility of learning on learners. So active learning happens when students are given the opportunity to take more interactive relationship with the subject matter of a course, encouraging them to generate rather than simply to receive knowledge. Here teachers facilitate rather than dictate the student's learning. On research supporting active learning Bonwell and Elson (1991) stated that, active learning strategies are comparable to lectures for achieving content mastery, but superior to lectures for developing critical thinking and writing skills. Another similar research by Meyer (2004), shows that active learning is an exceptionally effective teaching technique regardless of the subject matter, when active learning is compared to traditional teaching methods. Students learn more materials, retain the information longer and enjoy the class more.

Recently, a study conducted by Kirschner, Swelle and Clark (2007) compared result for college students in six different versions of a computer literacy course. In some groups instructional elements were left out (objectives, information, example practice with feedback, review). "The practice with feedback" is the active learning component of the study. They found in all cases, students who had practice with feedback (active learning) had better performance and more positive attitude than those students who did not have opportunity for practice with feedback. They related to content, students develop abilities in communication, leadership, ethical decision making and critical thinking.

### **Information and Communication Technology (ICT)**

Akudolu (2002), Opined that ICT refers to all kinds of electronic systems that are used for broadcasting, telecommunications and all forms of computer-mediated communications. ICT centered education involves the use of computer online self-learning packages, interactive CDs chips, satellites radio, optical, fiber technologies tele-presence systems and all types of information technology (IT) hardware and software. While Aliyu (2007), defined ICT as the use of computers and other electronic equipments for storing, analyzing and sending out information that are necessary for the process of acquiring and sending out information, ideas skills, knowledge, attitude, beliefs and feelings with the aim of bringing about particular changes in an individual.

In view of the above the paper sees ICT as the body of technologies and techniques, which are used to obtain, process and disseminate information to individual or groups. The technologies include electronics mail (E-mail), internet computer software and hardware, robotics, Computer Aided Learning (CAL), computer aided Instruction (CAI) Fibre optics and communication equipments.

### **Learning Strategies**

Bonwell and Elson (1991) in Osisioma (2005) suggested a step-by-step approach for science classrooms to be turned into more active learning environments. First, it is important to identify the teaching strategies you currently use and are comfortable with. Secondly select new strategies that are suitable for your class based on its particular content objectives. Thirdly, select particular ICT facilities that can best be used with such strategy. Finally, start with a few short, well-structured active learning activities that would ease students gradually into a more participatory approach.

Active learning strategy covers everything from in-class writing assignments field trips, using technology such as the computers to promote active learning in the classroom and cooperative group discussion, debates, presentations, role playing, simulations, problem solving, case studies, etc. whichever strategy you decide to use, the critical things is to implement learning strategies that are appropriate for your specific lesson objectives and that you feel comfortable with. These approaches to active learning can be effectively achieved using ICT through the following learning strategies.

1. Cooperative learning and small group activities
2. Individualized activities
3. Immediate Feedback
4. Critical thinking motivator

### **Cooperative Learning and Small Group Activities**

Cooperative learning is the type of active learning strategy in which students work in a more formally structured group rather than alone, to perform complex tasks, such as multiple-step activities, research project, or presentations in order to achieve a common goal (Cambell and Peccimin, 1999) in Osisioma (2005).

### **ICT Facility Applicable**

Cooperative learning can be achieved through effective use of E-portal, video clips and interactive radio programmes. Students can be grouped and task assigned to them to investigate or solve problems from the data provided. The learning materials is structured in such a way that it is interactive and participatory as possible to help each member of the group to learn Science Concepts That could be Learnt using the ICT Facilities. Insert life cycles, cell and its environment, reproduction in both plants and animals, relevance of Biology to agriculture etc.

### **Application in Teaching Science**

1. Video clips here teacher prepare video cassettes or using the computer power point facility and presents them to students group who study them with the teacher serving as a facilitator.
2. E-portal facility: Teacher prepares lesson note and sends it to the internet in his folder or even to the students' individual folders for them to learn individually or in groups.
3. Radio cassette recorders: Teacher records audio explanation of the teaching of particular science concept or process and provides to the respective groups for learning. The students play the cassettes and record information after which they are brought to the class and each group discusses what they have learnt.

### **Individualized Activities for Students**

In individualized instruction, students are given such as project, individual topic for discussion. The student undertake the activity by themselves while the teacher acts as a facilitator. These techniques of assigning individual activity to students Osisioma (2005) said are aimed at encouraging students exploration of their own attitudes and values. Therefore they can easily be used without interrupting the flow of the class. These activities are particularly useful in providing the science teacher with feedback concerning students' understanding and relation of materials which can be enhanced by using ICT facilities.

### **ICT Facility Applicable**

Individualized learning activities for students particularly science teaching include LCD projector, overhead transparencies; Video clips; computers and radio sets. The learning material is structure in such a way that it can facilitate individual learning.

Ecological concepts like feeding relationships among organisms, pollution, conservation of natural resources, food chains, saponification, electrolysis and energy flow in ecosystem etc.

### **Application in Teaching Science**

- i. LCD Project:- Teacher prepares the learning material for use in a projector to be projected by the student at his chosen time of learning or allocated time
- ii. Overhead transparencies: teaching and learning materials such as the life cycle of an organization or stages involved in animal reproduction, growth and development are prepared on transparencies for the individual students to study at his chosen time of the study.
- iii. Video clips: teacher could organize video slides or buy the prepared tapes for presentation to student to study with television sets. The clips can be put on slow motion for students effective understanding.

### **Immediate Feedback**

The use of ICT facilities in teaching science can be used to provide immediate feedback activity effectively. Unmediated feedback activities provide formative assessment rather than summative assessment of student' understanding. For immediate feedback, the teacher stops at appropriate point to give quick tests of the materials. In this way, he/she can adjust the lesson midcourse, slow down to spend more time on the concepts students are having difficulty with:

### **ICT Facility Applicable**

- i. Video through use of video clips presentation
- ii. Computer: The power point facility of the computer is used as a package for lesson presentation using slides of the lesson note
- iii. Projector Screens using the transparencies etc.

### *Science Concepts that could be learnt used the ICT Facilities*

Ecological concepts like feeding relationships among organisms, pollution, conversation of natural resources, food chains, saponification, electrolysis and energy flow in ecosystem etc.

### **Application in Teaching Science**

- i. Video Clips: Teacher uses video package prepared as clips and cells which the teacher can run and stopped at it intervals to assess students' learning outcome.
- ii. Computer: Using the power point package of computers, teachers prepare slides of their lesson notes and animate them for specific time e.g one minute or more for use in teaching to enhance retention ability of students of science concepts.
- iii. Projector Screen: Teachers of science can use projector screen to project diagrams to act as charts, illustrations, on the wall of the classroom from prepared transparencies etc.

### **Critical thinking Motivation**

This method attempts to get students involved in discussion of or thinking about learning material either before any theory is presented in lecture or after several conflicting theories have been presented. For example, use of video films to watch on ecosystems, reproduction etc before the lesson. The idea in the first case is to generate data or questions prior to mapping out the theoretical landscape of the concepts. In the second case, the students learn to assess the relative merit of several approaches used in teaching such concepts.

These can be achieved through pre-theoretic intuition quiz and puzzles/paradoxes

### **ICT Facilities Applicable**

- i. Video Conference
- ii. E-Mail/Fax
- iii. Phones

### **Science Concepts that could be Learnt Using the ICT Facilities**

Collection of specimens in Biology, titration in Chemistry, in Physics and related sciences, practical, life cycles of organism etc.

### **Applications in Teaching Science:**

1. For pre-theoretic intuition quiz, teacher can ask a set of prepared questions for pupils to answer using the hands free facility to provide answers to the short quiz. Here students are given the opportunity to observe a video conference call and say hello to initiate the conference. Another example is teaching of titration in chemistry here, the teacher asks students to put on the sides cassettes of titration procedure and uses his hand free to instruct the students.
2. E-mail/Fax: Teachers can use this to send drawings, diagrams and written formation as part of series of shared activities to students which can be typed out or read on the screen before the actual lesson takes place
3. Phone: Teachers can use phones to pass on actual lesson such as information required to complete a task, questions expected or list of items for collection in teaching of biology or for practical lessons.

### **ICT Education Facilities Accessible to Active Learning**

Linn (2003) in Ikyumen and Gbodi (2007) conformed that information and communication technology (ICT) have had a convoluted but ultimately advantageous impact on science teaching. The following ICT education programmes should be made more accessible to teachers and students for attainment of sustainable education and national development. Their effective integration and use in the teaching of science, technology and mathematics will go a long way to enhance their natural development (Jogour Mohammed and Abba 2006). These facilities include among others:

1. E-portal: This is a system of information accessing through the internet for use in teaching and learning, and general education management effectiveness. Under this network, students register online, receive lectures, do assignments, homework, tests and check results of their examinations on line using the user card which contains each student's pin number and user name. the teachers also use it to teach/lecture students at their convenience.
2. Mesh Network: This is the use of ICT devices like computers that operate on dry cell wet cell batteries and other alternative sources of power other than the national grid to facilitate teaching and learning because of their mobile nature, the government should incorporate them into the school programmes.
3. ICT based distant teaching and learning programme: The current distant learning programme by the centre of excellence in the teaching and learning of science technology and mathematics and general educational management.
4. ICT mobile classroom: Here children of all categories take classes in science way from the comfort of their homes in the remote areas, hilly, desert and very difficult terrains in the country through their mobile classrooms and teachers
5. School net project and programme: The current ICT school connect programmes for Nigeria schools if fully implemented will provide the opportunity for students of the poor access to the use of ICT facilities in teaching and learning.
6. The Nigerian Television Authority Foundation Connect Programme should be aggressively our sued by regular teaching programme for children participation in the country. This can be achieved through deliberate teaching programme in sciences on regular basis to popularize and encourage science among students as practiced in the 1980's.
7. Computer Assisted Instruction (CAI): Adequate computers should be made accessible to all schools in Nigeria for computer assisted instruction to be effective.
8. ICT Multipurpose Community Centre should be established in every ward and remote areas to make ICT facilities accessible to all and effective in teaching and learning.
9. The use of captioned videos in instructions in schools should also be made accessible for use by the handicapped children (Children with hearing impairment) such as captioned film, tapes, and television (Adeniyi and Egunjobi, 2006). Captioned videos allows the viewer to follow the dialogue and the action of a programme simultaneously. This made its use in the teaching and learning especially science very effective and relevant.

13. One laptop per child school project: This is a project aimed at ensuring that each Nigerian child of school age is provided with a laptop. This will enhance individualized learning.

### **Mode of using ICT Resources in Teaching and Learning**

According to Ayotola (2002) there are various modes of ICT applications in teaching and they include the following five modes as identified by Fluck (1996)

- i. Support Mode: This incorporate the use of (a) Word processing package (b) e-mail (c) Computer aided drafting and design and (d) desk-top publishing. That in these modes, the most applicable to science teaching is the use of the electronic mail.
- ii. Exploration and control mode: In this mode students can explore, examine, experiment with and build simulations. Software packages for this include, computer-based science simulations and games, databases and so on.
- iii. Tutorial mode: In this mode, information is presented at an appropriate level and pace for the user, giving the pupils, the opportunity to receive feedback on progress. Example of software on this is the CD Rom.
- iv. Resources mode: This is a mode very much applicable in the learning of science because it is used to access current information, data and relevant discoveries.
- v. Link mode: This technology is used for communication between individuals. For example, the E-portal provides link between teachers and their students to discuss reasons etc.

### **Golden Rules of ICT Use in Active Learning**

According to Ayotola, (2002) in using the various modes of ICT resources in teaching and learning, it is necessary to note the following ten golden when it comes to the actual use of ICT in day-to-day science classes as proposed by COX (200). They include:-

14. Identify the learning aims and objectives for the purposes, which can be enhanced by the use of ICT
15. Select appropriate ICT resources and facilities that enhance achievement of learning aims
16. Ensure that the pupils have enough ICT Skills to be able to carry out the activities.
17. Plan the schedules of the activities to include non-ICT tasks.
18. Plan enough lessons to enable activity to be completed.
19. Decide on the groupings of the pupils
7. Introduce the lessons to all the pupils first before working on any ICT facilities.
8. Intersperse the ICT activity with whole class guidance and direction
9. Allow enough time for the pupils to reflect and evaluate their achievements at the end of the lessons and
10. Allocate homework or other assessed work to pupils

### **Implication of ICT Facilities for Active Science Teaching**

The recognition of the growing need for adequate ICT access and active learning calls for appropriate strategies for effective science, technology and Mathematics teaching and learning. Okoye (2006) stated that, the application of ICT Based Distant Teaching and



Learning for Special Education in Nigeria could be achieved through effective application of the “mesh network” in the target schools in remote communities in the country.

The mobile classroom can effectively be achieved through the Mesh network'. Jongour et-al (2006) argued that, the technology needed to achieve this objective is already in place. Computers are everywhere now, wireless telecommunication are also readily available, internet is also available, even though it is still expensive. Multimedia applications are not cheap, experts to set up and man the projects are also not in short supply. All that should be added is government subsidy and private sector participation. Another implication is that the use of these facilities in the active learning will make science lessons more real, interesting and motivating for both students and teachers.

### **Conclusion and Recommendations**

It is therefore obvious that education for national development requires the use of ICT in virtual universities, Colleges and schools to provide the active learning required to achieve sustainable development. To reap the benefit of ICT in active learning and sustainable development of the country, other social services, telecommunication infrastructures, road transportation, must be improved upon. It is in this light than this paper recommends the following:

- i. Government policy should encourage ICT resource inflow for active learning by creating an enabling environment that will enhance access of all students to its facilities
- ii. Government should encourage the use of public institutions and electronic media (schools, libraries, hospitals, research centres, television houses) in introducing ICT based teaching and learning programme in science, while private entrepreneurs should be encourage to set up public access in the form of Cyber-Cafes in the remote areas accessible to all Nigerians;
- iii. Government should also create mass public awareness and training to enable Nigerian students and teachers make effective use of the services offered by the ICT centres as practiced in the Federal Colleges of Education, Yola, Adamawa State, where every student and teachers have access to the internet services, with all of them having folders in the internet (E-portal network).
- iv. Immediate implementation of one laptop per child (OLPC) programme should be made for effective integration of Nigerian students for the ICT active learning programme to be successful
- v. Tele-education is another viable area, which ICT has made possible for localized laboratories to share their experiences and findings globally through internet connectively.
- vi. Teacher training: There is need to adequately and urgently train the teachers for the various ICT programme especially active learning of sciences, technology and mathematics. It is our resolve that adequate implementation of these recommendations will enhance the use of ICT in active learning of science and therefore ensure sustainable development of Nigeria

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