

## Qualitative and Functional Biology Education: The Role of Information and Communication Technology

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### Abstract

Biology is an inquiry oriented subject which requires the use of various equipment to effectively teach it. The use of ICT creates a powerful environment and it transforms the learning and teaching process in which learners deal with knowledge in an active, self-directed and constructive way. The paper examined the benefits of ICT and challenges of their application to teaching and learning of biology. A descriptive survey model was used to investigate the availability and utilization of ICT tools by College biology teachers. Inadequate and in some instances complete lack of ICT tools and the non-utilization of the few ones available during biology instruction by teachers among others were the findings of this survey. The teachers, however, strongly agreed that ICT technologies enhances teaching, independent learning and understanding, motivate students to participate in learning activities among others. These translate into increased students' academic performances. It is therefore recommended that adequate ICT facilities be provided and teachers be trained to acquire innovative skills for ICT integration to biology teaching.

### Keywords

Qualitative, Functional, Biology education, Information and Communication Technology (ICT)

### 36. Introduction

Educational institutions are established for the purpose of teaching and learning and it is through this process that learners are transformed in knowledge, skills, socially, morally, politically and attitudinally to enable them become useful members of the society (1).

Biology is a branch of science that is concerned with the study of all types of living things and how they interact with their environment. It is one of the compulsory science subjects offered by students (art and science students) at senior secondary school level. Biology is also a requirement for senior secondary school graduates who want to study medicine (Human and Animal), Agriculture, Biochemistry and Microbiology at post-secondary education level. Bio-fermentation, bio-fertilizers, biofuels, bio-pesticides are enterprises that require indebt knowledge of Biology. According to (2), the objectives of studying biology as a subject in schools were:

- a. To critically analyze the activities of living things in the environment.
- b. To develop practical skills in handling scientific apparatus.

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- c. To promote positive disposition towards biological science and scientific enterprise.
- d. To employ concepts and methods acquired in the course, in new area of study and in everyday situations.
- e. To make a successful career in biology.

In order to achieve these laudable objectives of functional biology education, the challenges facing most schools (Secondary and tertiary levels) today must be identified and overcome. These challenges according to (3), (4), (5) and (6) include:

- Problem of large classes in which the numerical strength does not permit the teacher to cope effectively with the demand of the individual student. This could be that there are too many learners for one teacher or overcrowded class where there are too many learners for the available class.
- Inadequate equipment for practical.
- Inadequate and most often outdated learning materials.
- Inability to reach out to varying abilities of learners.
- Inadequate instructional materials for effective instruction delivery in biology and
- Most worrisome is the teacher centered strategy of instruction delivery etc.

Numerous teaching and learning strategies have been developed which correspond to the accommodation of students need and diverse learning method (7). The modern global trend is the use of ICT in effective implementation of the educational system. The need for information and communication technologies that allow accessing, questioning and evaluating the information is of great significance (8). It is shifting emphasis in learning environment from teacher-centered to learner-centered. In this teaching strategy, the teacher only guides or serves as facilitator of knowledge to the learners. In the same vein the students are no longer passive receivers of information but actively involved in their own learning process (1).

Information and communication technologies (ICT) are currently widely used in classrooms as tutor, tool, and tutee (9), thus attention is being focused on its effectiveness in teaching and learning.

The use of ICT in teaching and learning of biology cannot be an exception. Application of ICT in teaching and learning biology has been reported to have the potential of changing educational practices significantly (10). Introduction of ICT in Biology lessons can raise not only level of knowledge but student's attitudes towards biology as well (11). Moreso, today, the ability to work with information and communication technologies (ICT) is recognized as one of the key competencies necessary for success in life and competition in labor market (12).

Therefore, the use of information and communication technologies (ICT) for instructional purposes has become a need for individuals that constitute the information society. This need has made it compulsory for the paper to x ray the role of ICT in the attainment of qualitative and functional biology education for national integration (8).

### **37. Concept of ICT**

Information refers to the knowledge and ideas which are provided to increase awareness in people. Communication which involves a sender, a message, a transmission channel and a receiver is a process of transferring information from the person to another clearly and accurately. Technology is systematic method of working to achieve outcomes (13). Thus, ICT is the combined use of micro-electronics, computer hardware and software, telecommunications to enable the processing, storage and its dissemination of information (1).

In another perspective the term “Information and Communication Technologies” refers to transferring, storing, revealing and sharing technology or accessing information. Information and communication technologies include radio, television, video, DVD, phone (fixed and mobile), satellite systems, computer and network equipment and software as well as the equipment and services provided by these technologies (such as video-conference and electronic mail) (14) among others. (8). According to (15) ICT are electronic technologies used for accessing, processing, gathering, manipulating and presenting or communicating information. From the foregoing, it can be deduced that ICT integrates medial, informative and computer science education.

### **38. ICT and Qualitative and Functional Biology Education**

Biology is an inquiry oriented subject which requires the use of various equipment to effectively teach it. In so doing, the learner will not only learn the content of science but also acquire the science process skills, such as observing, classifying, manipulating, experimenting, interpreting and communicating. These science process skills are very critical in functional and qualitative teaching of biology (16)

The use of ICT creates a powerful environment and it transforms the learning and teaching process in which students deal with knowledge in an active, self-directed and constructive way (17). Recent happenings in knowledge and skill application ICT have affected teaching and learning of science (Biology inclusive). The need for teachers and learners of biology to have such practical abilities and skills for ICT use and, to integrate it into their teaching and learning processes cannot not be relegated to the background. ICT integration which according to (18) is meant to be cross curricular, has covered the continuum from instruction on programming skills, self-directed drill and practice, interactive learning software, online training, testing, instructional delivery augmentation, and internet-based accessibility to information, communication, and publication (19). ICT is used to develop students’ skills for searching and assessing information (stored in computers and other electronic based materials), cooperation, communication, and problem solving which are important for preparation of learners for the knowledge society (20).

As Biology includes complex relationships of unfamiliar and abstract concepts, it is difficult to learn and teach. The complex nature of biology also causes learners to experience difficulty in understanding certain concepts via memorization (8). In order to overcome these challenges, the use of ICT to present information visually through well prepared pictures, three dimensional models, animations, interactive environments have been reported to enhance the comprehension of the target information more easily (8).

It is critical in the teaching of biology to distinguish between generic and adapted or developed ICT applications. Generic applications are used in all subjects like word processing, searching for information, communication using e-mails and multimedia presentations. In this case if ICT is not used in a classroom, damage to the learners is often limited because they can achieve missing skills of their work in other subjects, or at home (21). While applications adapted to or developed to be used in science (such as biology) teaching include imaging systems, virtual dissections, simulations, virtual laboratory, modeling, animation, real laboratory exercise with data acquisition system etc. (22 and 23). In most cases students of biology not taught with adapted applications are not able to compensate loss with work in other subjects or at home.

### **39. Benefits of ICT to Teaching and Learning of Biology**

Studies carried out by (24), (25), (26), (27) and (3) revealed that application of ICT to teaching and learning of biology have the following benefits:

- High rate of retention, learning and recalling.
- Increased expertise in work force skills.
- Increased motivation.
- Added efficiency to classroom in both note – taking and amount of material covered.
- Promote computer literacy for lifelong learning.
- Bring learning to life.
- Provide efficient feedback in class.
- Accelerate, enrich and deepen basic skills in reading and writing.
- Engages students to learn as they become more independent and responsible for their learning by allowing learners in to progress at their own speed of learning.
- Network technologies encourages active learning, support innovative teaching.
- Study experimental areas (e.g. ecology of wild life) where the exercise involved are either too dangerous, too expensive or too time consuming.
- Conforms with 5 pillars of effective learning namely active, gender sensitive, consistent, meaningful and productive.
- Gives room for interaction between learners and his fellow learners, teachers, teachers and learners, brilliant learners and weak ones, males and females etc.
- Platform for collaborative learning by sharing experiences.

### **40. Challenges of integrating ICT to teaching and learning of Biology**

From the findings of several workers (28, 29, 30, 31 and 3), the following reasons were adduced to be responsible for the challenges faced in the integration of ICT to teaching and learning of biology in the classroom.

- High cost of ICT tools
- Inadequate supply
- Increased power failure
- Lack of ICT operational skills/competencies
- Inadequate infrastructural facilities

- Lack of quality and effective capacity building programme
- Poor funding of schools
- Lack of positive ICT attitude
- Ignorance of teachers on the ICT innovative materials
- Lack of time needed to fully prepare (i.e. to experiment, reflect, and interact) for the use of ICT
- Fear of a fault occurring that cannot be rectified and teaching being unsuccessful as a result
- Resistance to changes
- Unreliable internet access to connectivity
- Individuals characteristics such as educational level, age, gender, educational experience, educational experience, experience with computer for educational purpose and financial position
- Lack of parent and community support for ICT use.
- Unavailability of vision and plan about the integration of ICT to biology education by schools.
- Poor accessibility to up-to-date ICT infrastructure/materials.
- Lack of positive School culture that recognizes the relevance of ICT.
- Lack of ICT use attributes which includes relative advantage, compatibility with existing practices and beliefs, low complexity, observability and potential tri-ability.

#### **41. Survey of available ICT tools and their utilization by teachers of biology during biology teaching in College of Education, Minna**

##### **Purpose**

- a. To find out the type of ICT tools available to teachers of Biology.
- b. To identify the ICT tools used by teachers of biology during Biology instruction.
- c. To determine Biology teachers' perception on the benefits of ICT tools usage in teaching and learning of Biology.

##### **Research questions**

- a. What are the ICT tools available to Biology teachers?
- b. What numbers of ICT tools available are functional?
- c. What are the types of ICT tools used during Biology instruction by teachers of Biology?
- d. What are the modes of interaction between teachers of Biology and pre service NCE teachers of biology using ICT facilities?
- e. What are teachers' perceptions on the benefits of ICT utilization to learning of Biology?

#### **42. Methodology**

A descriptive survey model was used to carry out this investigation. All lectures in Biology department of Niger State College of Education, Minna, numbering eleven (11) were used. Information and communication technology availability and usage questionnaire IAUQ with seven (7) items was used to collect data. Likert four (4) point type of rating scale that ranged from

strongly agree (4 points) to strongly disagree (1 point) was used for some items in the questionnaire. Items with response means of 2.5 and above were regarded as positive while below were regarded as negative (32). The data collected were analyzed using mean and Percentages.

### 43. Results and discussion

The total number of biology Pre service NCE teachers obtained was 2554 (Table 1). This indicates that the recommended teacher and student ratio of 1:25 (33) and 1:35 (4) have not been complied with. Consequently, the problem of too many students for one teacher and overcrowded class might result. This culminates in the teacher not being able to cope with the demand of the individual student.

Table 1 Population of biology Pre service NCE teachers in Biology department

Level	Number of students
100	857
200	928
300	769
Total	2,554

#### **Research question 1:** What are the ICT tools used available to Biology teachers?

The data for answering the research question 1 were presented in Table 2.

Table 2 ICT tools available in Biology department. F is for frequency.

Item	Available (F)	Available (%)	Unavailable (F)	Unavailable (%)
Fax machine			11	100
Television	11	100		
Desk top computer	11	100		
Lap top computer	11	100		
LCD Projector	11	100		
Power point projector	11	100		
Video recorder & player	11	100		
DVD Player	11	100		
Internet service			11	100
Radio			11	100
Camera (motion & still)			11	100
Electronic white board (controlled by computer)			11	100

**Research question 2:** What numbers of ICT tools available are functional?

The data for answering the research question 2 were presented in Table 3.

Table 3 Number of functional ICT tools available in the Department

Item	Number
Fax machine	0
Television	1
Desk top computers	1
Lap top computers	1
LCD Projector	1
Power point projector	1
Video recorder & player	1
DVD Player	1
Internet service	0
Radio	0
Camera (motion & still)	0
Electronic white board (controlled by computer)	0

Only one each of television set, desk top and lap top computers, LCD Projector, power point projector, DVD player and Video recorder and player was available and functional in the Department. Comparing the total number of Pre service NCE teachers of biology (2554) and the number of available functional ICT tools (Tables 1 and 3), it was evident that functional ICT tools available were grossly inadequate for the attainment of quality and functional instruction delivery in biology. For example, in a computer aided instruction (CAI), the student to computer ratio of 5:1 is recommended (34) for effective teaching and learning to take place.

**Research question 3:** What are the types of ICT tools used during Biology instruction by teachers of Biology?

The data for answering the research question 3 were presented in Table 4.

Table 4 ICT tools used during biology instruction

Item	Strongly agree (4)	Agree (3)	Disagree (2)	Strongly Disagree (1)	Mean (X)	Remark	
							Fax machine
Television		01		10		1.09	-ve
Desk top computers				11		1.00	-ve
Lap top computers				11		1.00	-ve
LCD Projector				11		1.00	-ve
Power point projector				11		1.00	-ve
Video recorder & player		01		10		1.09	-ve
DVD Player		01		10		1.09	-ve

Internet service	11	1.00	-ve
Radio	11	1.00	-ve
Camera (motion & still)	11	1.00	-ve
Electronic white board (controlled by computer)	11	1.00	-ve

In Table 4 none of the ICT materials was used during classroom teaching. The highest mean value of 1.09 recorded for television set, video recorder and player, and DVD player were below the acceptance criterion mean of 2.5. This showed that the teachers have negative attitude towards ICT utilization during teaching because even the few ones available were not used.

**Research Question 4:** What are the modes of interaction between teachers of Biology and Pre Service NCE teachers of biology using ICT facilities?

The data for answering the research question 4 were presented in Tables 5 and 6.

Table 5 Teachers' mode of interaction with NCE Pre service biology teachers on the internet/online

Item	Strongly agree (4)	Agree (3)	Disagree (2)	Strongly Disagree (1)	Mean (X)	Remark
Regularly						
Irregularly						
Not at all				11	1.00	-ve

A mean value of 1.00 was obtained for teachers of Biology strongly disagreeing to their interaction with NCE Pre service teachers on the internet (Table 5). The unavailability of internet services at the department might be responsible (Table 4).

Table 6 Teachers' Interaction strategy with NCE Pre service biology teachers during biology class

Item	Strongly agree (4)	Agree (3)	Disagree (2)	Strongly Disagree (1)	Mean X	Remark
Video Conferencing (Virtual teaching)				11	1.00	-ve
Programmed Biology instructional software/package				11	1.00	-ve
Electronic mails for submission and feedback of assignments etc		1		10	1.18	-ve
Web based/Internet browsing of task given on biological topics/concepts		2		9	1.36	-ve

The highest mean value of 1.36 was recorded in web based/internet browsing task given on biological topics/concepts (Table 6). This indicated that teachers do not interact with their students using the strategies itemized in Table 6 during biology instruction. The grossly inadequate ICT tools and unavailable internet facility (Table 3) probably explains this finding.



**Research Question 5:** What are teachers' perceptions on the benefits of ICT utilization to learning of Biology?

The data for answering the research question 5 were presented in Table 7.

Table 7 Teachers' response to the benefits of ICT to learning of biology

Item	Strongly agree (4)	Agree (3)	Disagree (2)	Strongly Disagree (1)	Mean X	Remark
I have a personal computer	11				4.00	+ve
I am literate/proficient in computer usage	9	2			3.82	+ve
The available ICT tools are adequate for teaching students			3	8	1.27	-ve
I have a functional electronic mail (e-mail) address	9		2		3.64	+ve
I interact with my students on the internet			2	9	1.18	-ve
Use of ICT tool can enhance teaching and learning of biology	9	2			3.82	+ve
ICT use can enhance students' academic performance in biology	8	3			3.46	+ve
ICT can encourage independent learning and understanding of biology	8	3			3.46	+ve
ICT can help students' retention of abstract and difficult aspects of biology	4	7			3.36	+ve
ICT can motivate students to participate in learning activities in biology class	9	2			3.82	+ve

Except for availability of ICT tools and interaction with students on the internet responses that had mean values that were lower than the scale mean value of 2.5, which implied a negative perception among teachers (Table 7), all the items in Table 7 recorded mean values that ranged from 3.36 to 4.00. The mean values between 3.36 and 4.00, which were higher than the 2.5 critical mean value indicated a positive response by teachers. No wonder, despite the importance and significant investment in training and resources, in reality, schools are still far below the level of ICT use in science education (32).

#### 44. Conclusion

The use of ICT in teaching and learning is a global phenomenon and has come to stay. The use of ICT cut across all subjects, biology not an exception. ICT facilitate teachers teaching and enhance learners learning. Despite the importance of ICT to teaching and learning of biology, the changes observed through ICT Integration in teaching of biology in this study were much smaller than expected. Inadequate and sometimes complete lack of ICT materials coupled with the non-utilization of the few ones available during biology instruction by teachers were among the challenges of ICT use and integration into biology teaching. Therefore, teachers who are the major stakeholders in ensuring functional and qualitative biology education should avail themselves of

the opportunity to be ICT literate and utilize it in teaching and learning situations. Proprietors of schools were encouraged to provide adequate ICT materials for teaching and learning.

#### 45. Recommendations

From the findings of this study the following recommendations are hereby made:

- There should be software for every topic in biology to enable effective integration of ICT in teaching and learning of Biology
- Teachers should be regularly trained in order for them to acquire ICT skills and competencies for usability of ICT facilities during biology instruction.
- Adequate ICT facilities should be provided by relevant agencies to schools so as to cope with the increasing number of enrollments.

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