

Availability and Usability of ICT as an Instructional Strategy for Improving Teaching and Learning Biology in Nigerian Secondary Schools

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Abstract

A descriptive survey was carried out to investigate the availability and usability of ICT tools as a strategy for biology instruction in Nigerian secondary schools. **Materials and Methods:** The population for the study included all biology teachers in Ondo state; 60 biology teachers were randomly selected for this study, these included 30 biology teachers from the rural schools and 30 biology teachers from the urban center. A structured questionnaire which adopted a four-point Likert rating scale was employed. The questionnaire consists of three sections namely; Section A, which has three demographic data, Section B, which is on the availability of ICT tools in the secondary schools, Section C, which consists of fourteen (14) items on the competency of biology teachers and the usability of ICT in the implementation of Biology curriculum. The questionnaire was vetted by experts from Africa Center of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria, for content and face validity. **Results:** Findings from the study show that out of the (6) ICT tools identified for biology instruction in senior secondary schools, only (2) were adequately available (computer laboratory and generator), but not often utilized by the teachers for effective instruction in Biology, while the other tools were either not available or not adequately available. Furthermore, results from the study indicated that there is no statistically significant difference in the opinions of teachers from government and private schools, teachers from rural and urban schools on the availability and usability of ICT tools in senior secondary schools in Ondo State. Further analysis revealed no statically significant main effects of school status and school location on the responses of biology teachers ($p < 0.05$).

Keywords: ICT, Instructional Strategy, Availability, Usability and Biology Curriculum

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Introduction

Biology Education and ICT, Is There Any Link?

Education has been seen as a great tool for the development of human society, because it plays a major role in the impartation of knowledge and skills which enable mankind to think rationally. Thus, it is evident that the purpose of education is the acquisition of knowledge and skills to make informed and reasonable decisions. Therefore, from the foregoing, education enables a nation to achieve growth and development. Hence, the goal of education is defined as the transformation of man through the acquisition of required knowledge of societal values and civilizations which enable him to function in the society, optimal development of psycho-physical abilities, critical thinking and creativity. Furthermore, the importance of education to humanity informed the inclusion and diffusion of Information and Communication Technology (ICT) related instructional strategies and learning styles in the school system at all levels of education for effective teaching and learning, this is because effective teaching and learning is no more restricted to the four corners of school buildings anymore, but rather, learning can take place anywhere, anytime and any day. In this wise, teaching and learning requires innovative techniques such as Computer Assisted Instruction (CAI) which emphasizes the use of innovative instructional strategies.

Biology education on the other hand, is the scientific study of the structure, function, heredity, and evolution of all living things-microorganisms, fungi, plants, and animals. It is a science subject at the senior secondary level of Nigerian educational system. It is a natural science that affords students to learn about living organisms within their environment. Biology is a very important science subject needed not only by science students who may want to further their studies in the higher institutions, but it is very important for our daily living, as the knowledge of biology enables us to learn to manage our environmental resources; manage and cope with our biodiversity; and relate the importance of the environment to sustenance and well-being of humanity. ⁵ argued that because of its many advantages and the prospects it offers, biology, among other science subjects is the most popular choice offered by candidates sitting for the senior secondary school certificate examinations. However, in spite of the importance of the study of biology to mankind, there has been continuous decline in the achievement of students in public examinations conducted by the west African Examination Council (WAEC)

and the National Examination Council (NECO) in sciences across the country over the years (3, 17). Several topics, like water transport in plants, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics, Mendelian genetics, respiration and photosynthesis, genetic engineering, protein synthesis and the central nervous system can be perceived as difficult to learn by secondary school students. 19 also discovered that hormones, genes and chromosomes, mitosis and meiosis, the nervous system, and Mendelian genetics were considered difficult concepts by secondary school. Furthermore, studies by 8 revealed that students usually have difficulties in five major topics, which include nutrient cycling in nature, ecological management, and conservation of natural resources, pests and diseases of crops as well as reproductive system in animals. One important truth about the findings of all the studies about difficult topics in biology at the secondary school level is that nearly all the findings are the same. Several factors have been attributed to the perceived difficult topics in biology, among which are:

1. Difficult scientific terms and names
2. Teacher's understanding of the subject
3. Overloaded curriculum
4. The nature of the topics,
5. Teachers' style of teaching biology,
6. Students' learning and studying habits,
7. Students' negative feelings and attitudes towards the topics
8. Inadequate learning resources

According to 15, ICT has been described as a system of transmitting, receiving, processing, storage and retrieval of information in an electronic format, which has drastically changed the way we think, the way we live and the environment in which we live. This present dispensation came with a sensational digital breakthrough. Nowadays, we live in a society greatly transformed by information and communication technologies, in which, according to 11 this innovative transformation will greatly affect our society than that of exchange from oral to print society. This technological development leads to the needs for students to be active participants in information creation and utilization and to be able to communicate fluently and to be relevant both in their countries and the world at large. This technological advancement brought numerous changes in our daily lives, among which is learning technology for digital age. Learners in this computer age are faced constantly with a series of computer and social networking applications. As the new technologies continue to grow, they transform not only the learner's behaviors and needs but also theories and principles of learning processes, instructional design and applications.

4 opined that, Africa's infrastructural development is very critical, because it is a sine qua non in the economic growth and improvement of the living standards of Africans. It has played significant roles in human development, poverty alleviation, and the achievement of the Sustainable Development Goals (SDGs). Furthermore, it has been discovered that investment in infrastructure is responsible for over half of the recent developments in economic growth in Africa and has the potential for more improvement. From ranking based on infrastructural development, North Africa is still maintaining the first position and this is followed by Southern Africa, West Africa, East Africa and Central Africa respectively. The ICT sector, in the recent years has witnessed a great development which in turn has contributed to the economic development in most African nations. It is therefore not accidental that the top ten economies in Africa are those with the highest growth in their ICT sectors. However, unfortunately, Nigeria is not part of the best ten rated countries in Africa. Nigeria is rated 123rd position in the world and 25th position in Africa.

s/n	COUNTRIES	WORLD RATING	AFRICA RATING
1	Mauritius	47 th	1 st
2	Seychelles	63 rd	2 nd
3	Cape Verde	79 th	3 rd
4	Algeria	83 rd	4 th
5	South Africa	85 th	5 th
6	Ghana	88 th	6 th
7	Tunisia	90 th	7 th
8	Morocco	93 rd	8 th
9	Botswana	98 th	9 th
10	Egypt	100 th	10 th

Source: www.afterschoolafrica.com.

Schools in the 21st century will be bound with challenge-based learning and continuously attracting students to become more attracted to genuine issues that are important to mankind and inquiries that are of great and significant importance. The schools will go a long way past physical structures to the "nerves centers" with porous and transparent dividers that provide access not just to the teachers and students but everyone to the

abundance of information that exist on the planet earth and also facilitate a platform on which the players from all over the world can interact. So, it's a dramatic change from the text book, chalk and black board-driven, teacher centered and paper/pencil schooling to a purely student-centered learning system. The teacher is currently transformed from his essential duty as a dispenser of knowledge to facilitator of learning and helping learners to transform data into information and learning into knowledge, ¹⁹.

Pedagogies used in Biology Class

Several instructional materials and strategies have been used in the teaching and learning situation; for instance, the use of chalk board, bulletin board, overhead projector and computer. Nowadays, teachers can go online and find relevant topics or a research-based article, Computer games have been found to be effective in teaching difficult concepts in science and technology ¹³. As we all know that teaching is an attempt to help people acquire some skills, attitude, knowledge, ideas or appreciation. In other words, the task of a teacher is to create conducive environment, where learning can take effect or influence desirable changes in behaviour of his/her students. Consequently, an effective instructional strategy is the one that results in the students learning maximally from what they are taught. Therefore, it is not enough for teachers to be knowledgeable in the content area, but more importantly possess knowledge on how to transmit the knowledge to the learners. Hence, efficiency is about doing things right, while effectiveness is the bringing about of an effect that is in line with the goal.

The mediocre teacher tells

The good teacher explains

The superior teacher demonstrates

The great teacher inspires.

Candidates' Performance in May/June Senior School Certificate Examinations in Biology, Chemistry and Physics in Nigeria from 2007-2016

YEAR	TOTAL	CREDITS	%	TOTAL	CREDITS	%	TOTAL	CREDITS	%
	SAT	PASSES		SAT	PASSES		SAT	PASSES	
2007	1,238,163	413,211	33.37	422,681	194,284	45.92	218,593	180,797	43.24
2008	1,259,964	427,644	33.94	418,423	185,949	44.47	415,113	200,345	48.38
2009	1,903,552	644,733	33.87	422,091	194,035	45.97	429,174	186,940	43.56
2010	1,300,418	427,644	33.90	465,643	236,059	50.70	463,755	237,756	51.30
2011	1,505,199	579,432	38.50	565,692	280,250	49.54	563,161	360,096	63.94
2012	1,646,150	587,044	35.66	627,302	270,570	43.13	624,658	429,415	68.74
2013	1,648,363	854,743	51.73	539,296	143,218	72.34	637,023	297,988	46.77
2014	1,365,384	766,971	56.17	636,268	397,649	62.49	635,729	386,270	60.76
2015	1,390,234	798,246	57.42	680,357	412,323	60.60	684,124	410,543	60.01
2016	1,200,367	740,345	61.68	706,873	408,122	57.74	705,125	415,655	58.95
		Biology			Chemistry			Physics	

Sources: The West African Examinations Council (WAEC). Adapted from Abimbola (2013).

Students' performances in science subjects have been at the lower ebb with several factors attributed to it. ¹ was of the opinion that the observed poor performance in biology between 1991 and 2011 could be because non-science students used to register for biology as core science students. Biology as a science subject has been seen to contain so many scientific names, most of which students don't see as important to their lives. To be factual, many students don't see biology as a subject they can learn outside the school environment; they don't see the subject has been pertinent to their environment.

Information and communication technology (ICT) have proved to be the best option in the promotion of economic development, eradication of poverty and improvement of social welfare in any nation. This is the more reason many countries of the world, both developed and developing are investing heavily in ICT driven school curriculum. There are several teaching methods used in the Biology classroom all over the world. while some of these methods are based on philosophical principles, for examples lecture method, tutorial method, discussion method, individual discovery method; some are based on psychological principles derived from experiments, for examples, mastery learning, computer-assisted instruction and evolving instructional methods e.g. constructivist method, team teaching method etc., each of these methods surely has its strengths and weaknesses.

Technology has become so important to human survival and is cutting across every sector of our existence; there is hardly anything that one can do now without technology. This technological development has also benefited education immensely; for instance, it has been observed that in spite of the vast opportunities provided by lab-based STEM education, there are several factors that still inhibit the use of conventional hands-on labs, which include cost of setting up, in most cases non-availability, maintenance, frequency of use, etc. In order to address some of these issues new approaches have been initiated during the last two decades by employing Virtual and Remote Labs ¹⁰. Thus, the usefulness of technology in our day-to-day activities lies in the fact that it makes difficult activities simple. Students' performances in Biology at Senior School Certificate Examination

have not been too encouraging; ¹ reported a performance level of below 50% for individual science subjects in more than twenty-year period between 1991 and 2011 except occasionally for chemistry and physics, which were above 50%. Candidates' performance in biology over these years has never been up to 50%, however, ¹⁴ posited that there was a slight improvement in biology examinations results in the year 2013 to 2016 with a 50% and above credit pass which, is contrary to the existing results' history. This sudden improvement might be associated with improved teaching strategies from the teachers and other factors. Such an improvement might be sustained with the use of ICT tools.

Furthermore, in education, the use of technology has been found to play very important roles in teaching and learning context. For instance, many students are finding it difficult to learn some biological concepts, probably because of the nature of the subject or the methods engaged by the teachers, which do not afford students the opportunity to construct knowledge on their own. Specifically, ¹² stated that the learning of Biology in secondary schools has been hampered by the abstract nature of biological concepts and organizational level of the curricula. In addition, content organization of biology curricula and the quality of textbooks are some of the factors that hinder students from learning. However, all these problems could be solved when modern technologies are engaged in the Biology instruction. ²⁴ also posited that conventional method of teaching does not motivate students and as a result, they lose interest. To further explicate on the use of technologies in secondary schools in Nigeria, ¹⁷ found out that Computer Assisted Instructional materials (CAIM) were not frequently been used by teachers for instructional purposes. The use of computers was restricted to occasional information processing and for storage purpose. Furthermore, ²¹ reported that the availability and use of computers and internet access were very poor. Few secondary schools that can boast of computer laboratory are poor in internet access. However, in spite of the problems associated with the use of computer assisted instructional strategies, several studies indicated that the use of CAI is effective in teaching and learning situations. In a related study about the effect of Computer Assisted Instruction on the performances of Biology students, ²⁵ found out that students' performance is better when exposed to CAI than their counterparts exposed to the conventional classroom instruction. However, there was no significant difference in the performance of male and female students exposed to CAI. ⁹ in their findings stated that there was no statistically significant difference between students under multimedia instruction and their colleagues in the conventional teaching method. However, students in conventional teaching method had better retention than other group; this finding was in variance with ²⁵.

¹⁸ found that most teachers in Ogun State secondary schools do not have the required competency in ICT. Furthermore, teachers in the humanities have more competencies in ICT than teachers in the sciences. In the same vein, ² in a related study discovered that teachers' response to acquiring knowledge, skills and competence in the manipulation of ICT is on the rise without the quest for acquiring academic qualification. However, on the other hand, these findings are in variance with the findings of ⁶ which states that teachers' attitudes toward the acquisition of computer literacy skills and usage depreciate as they acquire high academic qualifications.

Problem of the Study

In spite of the several benefits of ICT in today's world, the adoption and use of ICT in the implementation of secondary school curricula in Nigeria is still in a dilemma. There have been calls for change from teacher-centered learning which involves the use of chalkboard and textbooks to students-centered learning which incorporates the use of ICT tools ¹⁶. The compelling usage of ICT in instruction and learning relies greatly on the availability of these facilities and the teachers' ability to utilize them. Research works in Nigeria have not focus deeply on how ICT can reduce the barriers to learning difficult concepts in biology. This present study was carried out to find the level of availability of ICT tools for biology instruction among senior secondary school students in Nigeria and teachers' proficiency in the use of these tools.

Research Questions

1. Is there adequate supply of ICT tools for biology instructions in Ondo State Senior Secondary Schools?
2. Will there be any statistically significant difference in the opinions of teachers from rural secondary schools and urban secondary schools in Ondo state on the availability and usability of ICT as instructional strategy for Biology in Ondo State?
3. Will there be any statistically significant difference in the opinions of Biology teachers in government schools and private schools on the availability and usability of ICT for Biology instruction in Ondo State?
4. Will there be any statistically significant main effect of school location and status of schools on the ICT competency level and usability of Biology teachers?

Hypotheses

H₀₁: There will not be any statistically significant difference in the opinions of Biology teachers in urban schools and rural schools on the availability and usability of ICT tools as instructional strategy for biology in Ondo state.

Ho₂: There will not be any statistically significant difference in the opinions of Biology teachers in government schools and private schools on the availability and usability of ICT tools as instructional strategy for biology in Ondo state.

Ho₃: There will not be any statistically significant effect of school location and school status on the ICT competency of Biology teachers in Ondo state.

Materials and Methods

A descriptive survey was carried out on biology teachers in both private and secondary schools in Ondo State Nigeria. A structured questionnaire which adopted a four-point Likert rating scale was employed. The questionnaire consists of three sections namely; Section A, which has three demographic data, Section B, which is on the availability of ICT tools in the secondary schools, Section C, which consists of fourteen (14) items on the competency of biology teachers and the usability of ICT in the implementation of Biology curriculum. The questionnaire was vetted by experts from Africa Center of Excellence for Innovative and Transformative STEM Education, Lagos State University, Nigeria, for content and face validity.

Statistical analysis: Cronbach's alpha yielded 0.74 for reliability test. The following analyses were carried out on the data collected: mean standard deviation, student's t-test and one-way mancova. Data were analyzed through IBM-SPSS Version 23.

Result

Research question 1: Is there adequate supply of ICT tools for biology instructions in Ondo State Senior Secondary Schools?

Availability of ICT Tools

Table 1: Mean, Standard deviation and of responses on availability of ICT TOOLS in secondary schools in Ondo State

S/N	ICT TOOLS	MEAN	STANDARD DEVIATION
1.	Computer Laboratory	1.00	0.00
2.	Internet Facility	0.15	0.36
3.	Electricity	0.90	0.30
4.	Virtual Laboratory	0.03	0.16
5.	Projector Screen	0.18	0.39
6.	Zoom Class/Telegram	0.13	0.34

Table 1 revealed that the ICT tools needed for Biology instruction in senior secondary schools had their mean value ranged between 0.03 and 1.00. This indicated that out of the (6) ICT tools, only (2) tools were adequately available (computer laboratory and generator). Although, all the schools have computer laboratories, but not often utilized by the teachers for effective instruction in Biology, while the other tools were either not available or not adequately available. The table also showed that the standard deviation of the responses of the respondents ranged from 0.00 – 0.39, indicating that there is a gap in the responses.

Research question 2: Will there be any statistically significant difference in the opinions of teachers from rural secondary schools and urban secondary schools in Ondo state on the availability and usability of ICT as instructional strategy for Biology?

Ho₁: There will not be any statistically significant difference in the opinions of Biology teachers in urban schools and rural schools on the availability and usability of ICT tools as instructional strategy for biology in Ondo state.

Table 2: Means, standard deviation and t-test comparing the responses of biology teachers in rural and urban secondary schools in Ondo state on the availability and usability of ICT tools as instructional strategies for biology.

Group	N	Means	S.D.	DF	T	P (sig. level)
Rural schools	30	1.9943	0.19930	58	-1.699	0.215 not sig
Urban Schools	30	2.1080	0.30750			

Finding: There is no statistically significant difference between opinions of biology teachers in the rural and urban schools on the availability and usability of ICT tools for biology instruction in Ondo state. {t (58) = -1.1699; P > 0.05}.

Decision: The null hypothesis is not rejected.

Research question 3: Will there be any statistically significant difference in the opinions of Biology teachers in government schools and private schools on the availability and usability of ICT for Biology instruction in Ondo State?

Ho₂: There will not be any statistically significant difference in the opinions of Biology teachers in government

schools and private schools on the availability and usability of ICT tools as instructional strategy for biology in Ondo state.

Table 3: Means, standard deviation and t-test comparing the responses of biology teachers in rural and urban secondary schools in Ondo state on the availability and usability of ICT tools as instructional strategies for biology.

Group	N	Means	S.D.	DF	t	P (sig. level)
Private Schools	30	1.9920	0.20533	58	-1.772	0.415 not sig
Govt. School	30	2.1103	0.30258			

Finding: There is statistically significant difference between opinions of biology teachers in the government and private schools on the availability and usability of ICT tools for biology instruction in Ondo state. $\{t(58) = -1.772; P > 0.05\}$.

Decision: Do not reject the null hypothesis

Research question 4: Will there be any statistically significant main effect of school location and status of schools on the ICT competency level and usability of Biology teachers?

H₀₃: There will not be any statistically significant main effect of (a) school location and (b) school status on the ICT competency of Biology teachers in Ondo state.

Levene's Test of Equality of Error Variances^a

Dependent Variable: Responses

F	df1	df2	Sig.
1.163	1	58	0.285

Test of Between Subject Effects

Source	Type III Sum of squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	.433 ^a	2	.216	3374	0.41	.108
Intercept	118.292	1	118.292	1844.695	.000	.970
Status	.239	1	.239	3.725	.059	.061
Location	.223	1	.223	3.472	.068	.057
Error	3.655	57	.064			
Total	256.525	60				
Corrected Total	4.088	59				

The results showed that the main effect due to school location $\{F(1, 57) = 0.059; p > .05\}$ and main effect due to school status $\{F(1, 57) = 0.068; p > .05\}$ were not statistically significant. None of the interaction effects were found to be statistically significant.

H₀₃: There will not be any statistically significant main effect of (a) school location and (b) school status on the ICT competency of Biology teachers in Ondo state.

H₀₃ is not rejected since there are no significant main effects of school status and school location.

Discussion

The result from data analysis indicated that all the sampled schools are equipped with computer laboratory, although, power supply from the public power source is not stable, all the schools have alternative means of power supply. However, from observations made in all the public schools, the alternative power source is only connected to the administrative offices. Furthermore, many of the computers observed in the public schools were obsolete, while it was observed that students in private schools have their personal computers. In addition, only the private schools have internet facility installed. The result also indicated that only one out of all the sampled schools has a virtual laboratory and only two private schools utilize zoom class and telegram.

The findings are in line with the works of Olokooba (2015), who found out that Computer Assisted Instructional materials (CAIM) were not frequently been used by teachers for instructional purposes. The use of computers was restricted to occasional information processing and for storage purpose and Ukpebor and Emwanta (2012), who reported that the availability and use of computers and internet access in secondary schools were very poor.

From data analysis, it was also found that the opinions of biology teachers from both rural and urban schools did not attain any statistical significant difference. All the respondents are of the opinion that the use of ICT tools for biology instructions is at the lower ebb in Ondo State. This finding is in agreement with the work of Ukpebor and Emwanta (2012), they reported that the availability and use of computers and internet access in secondary schools in Nigeria is very poor. Since the ICT tools are not available for instruction, the biology teachers may not have found it important to acquire expertise and improve their competency in the use of ICT tools for instruction in biology.

Conclusion

The implication of the above data presentation is that education in most Nigerian states is grossly under-funded; there is need for the stakeholders in education sector to urgently reconsider the percentage of the annual budget for education. If Nigeria will develop at the anticipated rate, the incorporation of ICT into the education sector is very important. The policy on the use of ICT in secondary schools is another factor that should be considered. It could be inferred that the political elites have been paying only lip service to technological development in Nigeria; there is need for a concerted effort to implement a robust policy that will cater for the provision of ICT tools in the secondary schools, training and re-training of all teachers so that they can be abreast of the latest development in the world.

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