ASSESSMENT OF CONTENT COVERAGE OF PRACTICAL ASPECTS OF BIOLOGY CURRICULUM IN SECONDARY SCHOOLS IN OSUN STATE

By
OWOYOMI, Sunday Damilola
owoyomi_sunday@lagosstate.gov.ng, 07065184322
Lagos State Teaching Service Commission, Lagos, Nigeria

ADETUNJI, Akeem Adedeji (Ph.D.)
aadetunji@oauife.edu.ng , 08033705234
Department of Science and Technology Education, Obafemi Awolowo University, Ile-Ife, Nigeria

And

EWUOLA, Waheed Oladele.
University of Ilesa, Ilesa, Osun State, Nigeria
waheed_ewuola@unilesa.edu.ng, 08056665381

Abstract
The study investigated the content coverage of the practical aspect of the Biology curriculum for senior secondary schools in Osun State, Nigeria. The study adopted a descriptive survey research design. The population comprised 178 Biology teachers and 13,340 Biology students of Senior Secondary Three (SS III) in Osun State. The sample for the study was 36 senior secondary school Biology teachers 931 students from 36 intact classes of SS III Biology students from 12 Local Government Areas of the State. A Researcher-Developed Checklist (RDC) was used as the instrument to collect data which were analysed using frequency count, percentages and mean. The result showed that the content of the practical aspects of the Biology curriculum were covered to a good extent in the teachers' diaries (poor = 25.00%, fair = 30.56%, good = 44.44%, $\bar{X} = 2.433$*) and lesson plans (poor = 16.67%, fair = 36.11%, good = 47.22%,* $\bar{X} = 2.578$*). but poorly covered in the practical workbook of the students (poor = 56.40%, fair = 26.11%, good = 25.59%,* $\bar{X} = 1.458$*). The study concluded that the content coverage of the practical aspect of the Biology curriculum for secondary schools in Osun State is on average (poor = 32.69%, fair = 27.59%, good = 39.72%,* $\bar{X} = 2.259$*). The study recommended that teachers should dedicate at least one period per week for practical classes and allocate marks for practical works in the continuous assessment.*

Keywords: Assessment, Curriculum, Biology, Practical, Content Coverage

Introduction

Without a set schedule of contents, learning may not occur. The entirety of what students are to be taught and learn is referred to as content. These contents are contained in the curriculum and are expected to be taught by teachers during an academic period of time. Curriculum content is typically informed by educational standards, subject-specific frameworks, and learning objectives that guide the selection and structuring of topics within a course or

program. Effective curriculum design considers factors such as cognitive development of learners, relevance to real-world applications, and cultural appropriateness to ensure meaningful and comprehensive learning experiences. A curriculum can be operationally defined as properly prepared content with specified learning outcomes. A curriculum, according to Glatthorn, Boschee, Whitehead and Boschee (2019) is a set of plans made for guiding learning in the schools, usually represented in retrievable documents of several levels of generality, and the actualization of those plans in the classroom, as experienced by the learners and as recorded by an observer; those experiences take place in a learning environment that also influences what is learned. The curriculum includes the aims, objectives, teaching content, teaching strategies, assessment methods, and other components of learning and teaching in classrooms (Siu & Wong, 2015). Similar to this, Graves and Garton (2017), perceives a curriculum to the scholarly materials that will be taught in classrooms of a given educational course or courses of study; that is, it could be math, physics, English, etc.

The Federal Ministry of Education originally issued the national curriculum for senior secondary schools in 1985, and one of the disciplines included in that curriculum is Biology. In 1977, the Biology curriculum was first made available. The secondary school curriculum at the time lasted five years. In class four, Biology lessons began, and in class five, pupils took the West African School Certificate Test. The curriculum was expanded in subsequent curriculum reviews to keep up with the dynamics of social change and educational expectations. Biology is a captivating subject that ranges from microscopic cellular molecules to the biosphere, encompassing the earth surface and its living organisms (Olayinka, 2016). The objectives of the high school Biology curriculum are based on the National Policy on Education, which was first presented in 1977 and revised in 1981, 1998, and 2004. (FRN, 2004). The main objectives are to prepare students with adequate laboratory and field abilities, relevant and appropriate biological knowledge, the ability to apply science to real-world problems in agriculture and one's own and others' health, and a pragmatic and rational approach toward science.

The Biology curriculum has a spiral arrangement of content. The major content of Biology, curriculum are: Concept of living; Basic ecological concepts; Plant and animal nutrition; Body Systems, Variations and variability; Evolution and genetics. Based on this spiral arrangement, the concepts to be taught are arranged in such a way that topics are repeated yearly, throughout the three years of the course; to cover the 62 units in the Biology curriculum. Any repeated concept is discussed in greater complexity and depth as the course matures over the three year period. The contents of the senior secondary school Biology curriculum places emphasis on field studies, guided discovery, laboratory techniques, and skills. The curriculum for teaching Biology in senior secondary schools emphasized the relationship between the living and non-living things; relevance of Biology to agriculture; the structure and physiology of organisms; some basic ecological concepts; the conservation use of natural resources; lands, plants, and animals-their variations, populations and implications, adaptation; theories of evolution and application of the principle of heredity in agriculture and medicine.

The Biology curriculum for secondary schools contains a list of topics and subtopics to be covered. This content gives the teacher a guide on what the students should learn under a particular topic throughout their academic years. Some of the contents in the Biology curriculum are practice-oriented as they require students to perform physical activities, such as observing, studying, dissecting, identifying, examining, and many more. Ali (2006) defines practical activities as the various technical work components, systematically carried out with the aim of creating a product or explaining scientific phenomena. Examples include performing tasks like sorting specimens, dissecting specimens, and observing growth rates, evaluating organic matters, and conducting biological experiments. Biology practical exercises give students the chance to practice science rather than just learn about it (Ali, 2006). Hence, hands-on activities form the foundation of Biology education. These hands-on exercises could aid students in learning fundamental abilities including naming, identifying, drawing, labeling, spelling, and many other skills.

Practical work is considered a well-established and integral part of secondary school science, according to Poppe, Markic, and Eilks (2010). Similarly, Aladejana and Aderibigbe (2007) demonstrates that the inclusion of practical works into the teaching process improves students' understanding and performance in science, particularly Biology. Learners will be able to better understand fundamental biological ideas and expand their scientific abilities in well-designed practical classes. Jenkins and Nelson (2005) further confirm that engaging in practical activity makes students more proficient in learning science. According to Nzewi (2008), practical work (approach) can be seen as a tactic that can be used to make a teacher's job (teaching) more relatable to the students as opposed to the abstract or theoretical presentation of facts, principles, and subject-specific concepts. He continued that practical activities (method) should involve the students in hands-on, cognitive tasks while utilizing a variety of teaching resources/equipment to reinforce the lesson. Several studies (Agu (2006), Soyibo (2008), and Yabugbe (2009)) appreciated the incorporation of practical works into the Biology curriculum. However, evidence suggests that even though many students find Biology interesting and enrol in senior secondary schools to study it, many of them consistently achieve subpar results, as demonstrated by Okebukola and Akinbola (2008) and Ogunmade (2005).

Almost every topic in the Biology curriculum contains practice-oriented content and activity expected to be implemented. If these practical contents of the Biology curriculum are not fully covered, there would be a gap between what is learnt and what is expected to be learnt. Therefore, the contents of the curriculum must be timely and fully covered to enhance efficient and effective curriculum implementation. Similarly, the practical contents in the Biology curriculum are tested separately in qualifying examination like the West African Examination Council (WAEC) and National Examination Council (NECO). Candidates are often tested on their abilities to identify, spell, name, draw, and label biological specimens as well as their ability to relate the structures of the specimens to functions. Over the past few years, the WAEC Biology Chief Examiner has identified a general weakness of candidates in some skills, such as spelling, naming and drawing, which are linked to the practical aspect of Biology (WAEC Chief Examiner's Report, 2015–2022). These have contributed to a general unsatisfactory performance of candidates in external Biology examinations. If this problem persists, the objectives of the national curriculum may not be achieved and can become a

syndrome, especially with successive generations of Biology students. Since the skills of spelling, naming and drawing have been linked to the practical aspects of the Biology curriculum, this research will assess the extent to which these practical contents are being implemented.

Curriculum assessment is essential in ascertaining whether the stated objectives have been achieved. Assessment can be described as the procedure that fully reveals the value of the curriculum and the reality of what happens to it when it is put into practice. This process often employs various methods including curriculum mapping, analysis of instructional materials, and assessment data to evaluate the extent to which learning goals are achieved across different levels of education—from primary to tertiary. It also includes gathering and analysing data from numerous sources in order to sustainably improve student learning (Peter, Art & Fred, 2006). While further highlighting the fundamental justifications for curriculum assessment, Peter *et. Al.* (2006) explains that curriculum assessment is important; to determine which parts of a curriculum are effective and which ones need to be changed; to evaluate the success of adjustments that have already been made; to show the success of the current program; to satisfy professional certification criteria; and to meet periodical programme review requirements. It provides valuable insights into the effectiveness of teaching strategies, curriculum implementation fidelity, and the overall coherence of educational programs. The assessment of content coverage of Biology curriculum is essential in understanding the extent to which the practical aspects of the curriculum are covered.

The evaluation of curriculum content coverage is a critical aspect of educational assessment, ensuring that learning objectives are effectively addressed and educational goals are met. The concept of curriculum content refers to the knowledge, skills, and competencies that educators aim to impart to students within a specific subject area or course. It encompasses both the breadth and depth of topics covered, as well as the sequencing and organization of instructional materials. Assessing content coverage involves examining the alignment between the intended curriculum (what educators plan to teach), the implemented curriculum (what is actually taught), and achieved curriculum (what students learn). Thus, curriculum assessment is essential for identifying gaps, redundancies, and areas where instructional focus may need adjustment to optimize learning outcomes.

Hassan (2019) conducted a study on the "extent of implementation of Biology curriculum in public secondary schools in Maiduguri Metropolis, Borno State, Nigeria". The research adopted a survey descriptive research design. 451 SS 3 Biology students and 59 Biology teachers were randomly selected and sampled for the study. The data collected were analysed using arithmetic mean and standard deviation. The research found that the practical Biology contents were not fully covered, laboratory/discovery teaching methods were seldom used and the method of evaluation were mere multiple-choice and fill-in-the gap questions. The study concluded that public senior secondary school Biology teachers do not cover the Biology contents and do not comply with the recommended teacher activities and assessment method. The study further recommended that teachers should follow the recommended teaching and assessment procedure as contained the in the Biology curriculum for secondary schools.

Oladamola (2020) carried out a study on the "assessment of the implementation of contents for secondary school Biology Curriculum in three states in the southwest, Nigeria". The research adopted a survey description research design. 180 Biology teachers drawn from randomly selected secondary schools in Osun, Ondo, and Oyo States through a multi-stage sampling procedure were sampled for the study. The data collected using the Inventory on Implementation of Biology Curriculum (IIBC) instrument were analysed using simple percentages and analysis of Variance. The study discovered that the theoretical and practical components of the Biology curriculum were not adequately addressed and that most schools did not adhere to the recommendation of at least two times per week for practical work in Biology. The study so suggested that Biology teachers step up their efforts to ensure that the Biology curriculum's contents are completely covered and applied.

The results from all of these empirical studies predicts a wide gap between the recommendations of the Biology curriculum and what is obtainable in the practical classes of different schools. Meanwhile, the practical contents in Biology curriculum are tested separately in external qualifying examination like West African Examination Council (WAEC) and National Examination Council (NECO). In WAEC Biology examination, practical Biology totals 80 marks out of the net 200 marks which is 2/5 of the total obtainable marks (WAEC Biology Marking Guide, 2023). This score could also be seen as an indicator of how important the practical aspect of Biology is in science education. Despite the importance, students still struggle to relate their practice experiences with their theoretical work. This is demonstrated by students' low or falling achievement in science subjects (Ogunmade, 2005).

Meanwhile, a highlight of Osun State students' performance in the West Africa Examination Council (WAEC) Biology examination shows that only 18.31% of candidates who sat for the Biology examination in 2014 passed. In 2015, 18.80% of candidates passed the examination while the percentage rose to about 46.54% in 2017. The score maintained a considerably high percentage in 2018 and 2019 with 43.21% and 41.59 respectively. The breakdown of the Osun State WAEC results for Biology is presented in the table below:

Table 1: The performance of candidates in WAEC Biology examination between 2014 and 2019 in Osun State.

Year	Grade of students										
	No of cand.	A1	B2	B3	C4	C5	C6	D7	E8	F9	% PASS
2014	9,403	0	01	61	144	304	1,212	1,361	1,843	4,477	18.31
2015	11,662	0	03	72	228	455	1,434	1,306	1,863	6,301	18.80
2017	3,986	0	05	127	263	355	1,105	858	652	621	46.54
2018	7,611	04	41	223	443	611	1,967	1,969	1,447	906	43.21
2019	3,910	09	29	249	331	308	700	570	458	1,256	41.59

Source: Osun State WAEC Biology Result Database for 6 years

The WAEC Biology Chief Examiner has partly linked this unsatisfactory performance of students in Biology examination to their poor content coverage, among others (WAEC Biology Chief Examiner's Report, 2014 – 2019). While several research has shown a high content coverage of the theoretical aspect of the curriculum (Ifelobu, 2014; Ityokyaa & Adejoh, 2014; Hassan, 2019) little work has been done on the content coverage of the practical aspect of Biology curriculum. When the practical contents of the Biology curriculum are not fully covered, students may miss out on vital experiences that could help to improve their mastery of basic biological concepts. Hence, this study assessed the content coverage of the practical aspect of the Biology curriculum.

Research questions

The following research questions were raised for the study:

1. To what extent does the teachers' diary cover the practical aspects of the Biology curriculum?
2. To what extent does the lesson plan of the Biology teachers in Osun State cover the practical aspects of the Biology curriculum?
3. To what extent were the practical aspects of the Biology curriculum carried out in the classroom/laboratory?

Methodology

The study adopted a descriptive survey design that requires the collection of useful data from a representative sample of the population. The population for the study comprised of all the 178 Biology teachers and 13,340 students in Osun State in the 2021/2022 session. SS III students were chosen because they have been taught a larger percentage of the Biology curriculum. The sample for the study was 36 Biology teachers and 931 from 36 intact classes of SS III Biology students which were selected through a multi-stage sampling procedure. All the three Senatorial Districts in Osun State were considered for the study. Four Local Government Areas (LGAs) were selected from each senatorial district using a simple random sampling technique. Three secondary schools were selected from each of the LGAs through a simple random technique.

Research Instrument

A Researcher-Developed Checklist (RDC) for Biology curriculum content coverage was used to investigate the content coverage of the practical aspects of the Biology curriculum for secondary schools in Osun State. The instrument was presented to two science education and curriculum experts and two WAEC Biology examiners in Osun State for face and content validity. In the RDC, practical contents for each topic as contained in the Biology curriculum were rated as they apply to each sample population. The rating was done in three stages; by comparing the practical contents in the diary with that of the curriculum, scanning the teachers' lesson plan for these activities, and checking the practical workbooks/notes of the learners to see if the activities were carried out.

Research Question 1: To what extent does the teachers' diary cover the practical aspects of the Biology curriculum?

To answer this research question, the researcher compared the practical contents of the Biology curriculum with the contents in the Teachers' diary. The researcher utilised a checklist containing the practical contents and activities of the Biology curriculum to ascertain whether each practical activity is captured and covered in the teachers' diary. The data obtained from the checklist are presented in Table 1.

Table 1: The Result Obtained from the RDC Used to Assess the Extent to which Teachers' Diary Covers the Practical Aspects of the Biology Curriculum in Secondary Schools in Osun State

Item	Rating	Frequency	Percentage	Mean	Remark
i. Coverage of Teachers' Diary	a. Poor	9	25.00	2.433	High
	b. Fair	11	30.56		
	c. Good	16	44.44		

Source: Research Survey, 2022
Decision Rule:
Low = 1.0 – 1.67
Moderate = 1.67 – 2. 34
High = 2.34 – 3.00
Rating Key:
Poor = No practical contents was seen/observed
Fair = Few practical contents were covered
Good = Practical contents were fully covered

Table 1 above shows the observations recorded using the researcher-developed checklist. When the researcher compared the practical contents of the curriculum with the contents in the teachers' diaries, 25% of the teachers had poor content coverage, 30.56% had fair content coverage and 44.44% had good content coverage.

Outcome: The teachers' diary covered the content of the practical aspects of the Biology curriculum for secondary schools in Osun State to a good extent [$\bar{X} = 2.433$].

Research Question 2: To what extent does the lesson plan of the Biology teachers in Osun State cover the practical aspects of the Biology curriculum?

To answer this research question, the researcher compared the practical contents of the Biology curriculum with the contents of the Teachers' lesson plan. The researcher utilised a checklist containing the practical contents and activities of the Biology curriculum to ascertain whether or not each of the activities is covered in the teachers' lesson plan. The data obtained from the checklist are presented in Table 2.

Table 2: The Result Obtained from the RDC Used to Assess the Extent to which Teachers' Lesson Plans Cover the Practical Content of the Biology Curriculum in Secondary Schools in Osun State

Item		Rating	Frequency	Percentage	Mean	Remark
i.	Adequacy of Teachers' lesson plan	a. Poor	6	16.67	2.578	High
		b. Fair	13	36.11		
		c. Good	17	47.22		

Source: Research Survey, 2022
Decision Rule:
Low = 1.0 – 1.67
Moderate = 1.67 – 2. 34
High = 2.34 – 3.00
Rating Key:
Poor = No practical contents was seen/observed
Fair = Few practical contents were covered
Good = Practical contents were fully covered

Table 2 above shows the observations recorded using the researcher-developed checklist. When the researcher compared the practical contents of the curriculum with the contents in the teachers' lesson plan, 16.67% of the teachers had poor content coverage, 36.11% of the teachers had a fair content coverage and 47.22% of the teachers had good content coverage.
Outcome: The teachers' lesson plan covered the content of the practical aspects of the Biology curriculum for secondary schools in Osun State to a good extent [$\bar{X} = 2.578$].

Research Question 3: To what extent were the practical aspects of the Biology curriculum carried out in the classroom/laboratory?

To answer this research question, the researcher compared the practical contents of the Biology curriculum with the contents in the practical workbook of the students. The researcher utilised a checklist containing the practical contents and activities of the Biology curriculum to ascertain whether or not these practical contents were carried out in the classroom by checking the practical workbook of the representatives of the students drawn using a systematic sampling technique. The data obtained from the checklist are presented in Table 3.

Table 3: The Result Obtained from the RDC Used to Assess the Extent to which the Practical Aspect of the Biology Curriculum are Carried Out in Secondary Schools in Osun State

Item		Rating	Frequency	Percentage	Mean	Remark
ii.	Coverage of Students' practical workbook	a. Poor	525	56.40	1.458	Low
		b. Fair	150	16.11		
		c. Good	256	27.50		

Source: Research Survey, 2022
Decision Rule:

Low = 1.0 – 1.67
Moderate = 1.67 – 2. 34
High = 2.34 – 3.00
Rating Key:
Poor = No practical contents was seen/observed
Fair = Few practical contents were covered
Good = Practical contents were fully covered

Table 3 above shows the observations recorded using the researcher-developed checklist. When the researcher assessed the students' practical workbooks/notebooks, 56.40% of the students had poor content coverage, 16.11% of students had fair content coverage, and 27.5% of the students had good content coverage.

Outcome: The contents of the practical aspects of the Biology curriculum for secondary schools in Osun State were covered to a poor extent [$\bar{X} = 1.458$].

DISCUSSION OF RESULTS

The study discovered that the practical contents of the Biology curriculum were covered to a good extent in the teachers' diaries and lesson plans. However, the students' practical workbook showed that these practical activities were not implemented in the classroom. This could be because the teachers focused more on implementing the theoretical aspect of the curriculum, taught abstractly, and adopted teaching methods that encouraged students to construct knowledge independently. Some other reasons observed were the large content volume of the Biology curriculum, large class size, the interest of teachers and students, the inability of teachers to designate periods for practical contents of the curriculum and the utilization of traditional note-taking which is analogous to lecture methods for large classes. The result of this study is consistent with that of Oladamola (2020) who discovered in the study conducted in three states (Ondo, Osun and Oyo) in the southwestern part of Nigeria that the practical contents of the secondary school Biology curriculum were not fully covered. A plausible reason why practical Biology contents were not fully covered could be because of large Biology content or large class size (Okafor & Okoli, 2015). Another possible reason why the secondary school teachers in Osun State do not fully cover the practical contents of the Biology curriculum could be that most teachers were unable to meet up with at least two practical sessions per week, which is the standard for practical classes in secondary schools in Biology (Oladamola, 2020).

The result of this study is in line with the findings of Hassan (2019), who discovered in his study conducted in Borno State that practical contents are seldom taught in class. The findings of this study also align with the findings of Daba and Anbesaw (2016) who conducted a study in North-East Ethiopia and reported that more than 68% of the teachers do not utilise practical activities in teaching science subjects and that more than 78% of the teachers do not cover the practical works in the curriculum. The findings of the research could also be partly linked to the report of Farzana (2014) who discovered during his study in Afghanistan that teachers' implementation of laboratory work follows a traditional cook-book style characterized by a low inquiry style of teaching. This may possibly be the reason why Ifelobu (2014) concluded that the national curriculum's secondary school Biology goals and

objectives were only moderately met in his examination of Anambra State's secondary school Biology students.

CONCLUSION AND RECOMMENDATION

The study found that the content of the practical aspects of the Biology curriculum was covered to a good extent in the teachers' diaries and lesson plans but poorly covered in the practical workbook of the students. These findings are partly linked to poor lesson planning, large class size, large content size, unavailability of laboratories, time factor, and many more. The study, therefore, concluded that the content coverage of the practical aspect of the Biology curriculum for secondary schools in Osun State is on the average. The study thus recommends that teachers of Biology should devote at least one period per week to practical aspects of the curriculum, collect and provide specimens for practical activities, adequately plan for practical works and students should be examined on practical aspects of Biology as part of the continuous assessment.

REFERENCES

Agu, U. (2006). Science teaching in Nigeria. Enugu: Stirling Press

Aladejana, F. & Aderibigbe, E. O. (2007) 'Science Laboratory Environment and Academic Performance', *Journal of Science Education and Technology, 16*(5), 500–506. DOI: 10.1007/s10956-007-9072-4.

Ali, A. (2006). Analysis of Research in Teaching and Learning the Natural Sciences. Nigerian Education Research Association: *Aspects of Nigerian Educational Research Literature. 2* (1). 252-253.

Ali, A. (2006). Analysis of Research in Teaching and Learning the Natural Sciences. Nigerian Education Research Association: *Aspects of Nigerian Educational Research Literature. 2* (1). 252-253.

Daba, T. M., &Anbesaw, M.S. (2016). *Factors affecting implementation of practical activities in science education in some selected secondary and preparatory schools of Afar Region, North East Ethiopia*. Retrieved from https://www.researchgate.net/publication/307014741_Factors_affecting_implementation_of_practical_activities_in_science_education_in_some_selected_secondary_and_preparatory_schools_of_Afar_Region_North_East_Ethiopia

Dillon, J. (2008) A *Review of the Research on Practical Work in School Science.* London: King's College

Farzana D. (2014). *Biology Teachers' Perception of Laboratory Work in Afghanistan.* Retrieved from https://www.diva-portal.org/smash/get/diva2:813327/FULLTEXT01.pdf

Federal Republic of Nigeria (2004). *National policy on education*; Lagos: NERDC Press.

Glatthorn, A. A., Boschee, F., Whitehead, B. M., & Boschee, B. F. (2019). *Curriculum leadership: Strategies for development implementation* (5th ed.). California: SAGE Publications Ltd.

Graves, K., & Garton, S. (2017). An analysis of three curriculum approaches to teaching English in public-sector schools. *Lang. Teach., 50*(4), 441-482. https://doi.org/10.1017/S0261444817000155

Hassan, B. G., (2019). Extent of implementation of Biology curriculum in public secondary schools in Maiduguri Metropolis, Borno State, Nigeria. *Journal of Arts, Science and Commerce, 10*(1)

Hofstein, A. & Lunetta, V.N. (1982). The role of the laboratory in science teaching: Neglected aspects of research. *Review of Education Research*, 52 (2): 201-217

Ifelobu N. R. (2014). *Evaluation of the Implementation of National Curriculum for SecondarySchool Biology in Anambra State*. Unpublished Doctoral Degree Thesis, University of Nigeria, Nsuka

Ityokyaa F. M., and Adejoh M. J., (2014). Evaluation of the Implementation of BiologyProgramme in Secondary Schools in Benue State of Nigeria. *Journal of Modern Education Review, 4*(11), 970–977 Doi: http://10.15341/jmer(2155-7993)/11.04.2014/012

Jenkins, E. W. and Nelson, N. W. (2005) 'Important but not for Me: Students' Attitudes Towards Secondary School Science in England', *Research in Science & Technological Education, 23(*1), 41–57. doi: https://doi.org/10.1080/02635140500068435.

Millar, R. (2004) *The Role of Practical Work in the Teaching and Learning of Science*. Paper prepared for the committee: High School Science Laboratories: Role and vision, national academy of science. Washington Dc. York: University of York.

Nzewi, U M (2008) Effective *Communication of Integrated Science to Learners: The Need for and Use of Inquiry Strategy* Retrieved from https://www.unn.edu.ng/publications/files/NWOSU_NZEWI_08.pdf

Ogunmade, T.O. (2005). *The status and quality of secondary science teaching and learning in Lagos State, Nigeria*. Retrieved from https://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1086&context=theses

Okafor C.U., Okoli S. O., (2015). *Effective Utilization of Laboratory Method in Teaching BiologyPracticals in Secondary Schools*. Retrieved from https://www.academia.edu/34642320/effective_utilization_of_laboratory_method_in_teaching_Biology_practicals_in_secondary_schools

Okebukola, P. &Akinbola, U. (2008) Resources for Teaching. *Science Education Review 3* (1), 10-14.

Oladamola. A. (2020). Assessment Of The Implementation Of Contents For Secondary School Biology Curriculum In Three States In Southwest, Nigeria. *Advances in Social Sciences Research Journal. 7*. 270-276. 10.14738/assrj.77.8614.

Olayinka, A. (2016). Evaluation of the implementation of national curriculum for senior secondary school Biology in Southwest, Nigeria. An unpublished Ph.D. thesis, Ekiti State University, Ado-Ekiti

Onwuka, U. (2004). *Curriculum development for Africa*. Awka: Africana FEP Publishers.

Poppe, N., Markic, S. and Eilks, I. (2010) 'Low-cost Experimental Techniques for Science Education. *TEMPUS 2*(4) 15-29.

Siu, K. W. M., & Wong, Y. L. (2015). Soft and hard technologies in technology education. In M. Khosrow-Pour, S. Clarke, M. E. Jennex, A. Becker & V. Anttiroiko (Eds.), *Curriculum design and classroom management: Concepts, methodologies, tools, and applications* (pp. 378-391). PA: Information Science Reference (an imprint of IGI Global).

Soyibo. U. (2008*). Quality of Science Teaching in Nigeria*: Ibadan: University Press

West African Certificate Examinations (2004). *Biology WASSCE Curriculum*. Lagos: WAEC.

West African Certificate Examinations (2014 - 2019). *Biology Chief Examiner's Report*. Lagos: WAEC. Retrieved from https://www.waeconline.org.ng/e-learning/Biology/Biomain.html

Yabugbe. (2009). Recent Advances in Science Teaching in Nigeria. *Journal of Teaching and Learning 3* (1), 6-10