

Effects of Sequential Teaching Methods on Senior Secondary School Biology Students' achievement in Niger State, Nigeria

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Abstract

The study investigated the effects of Sequential Teaching Methods on senior secondary school Biology students' achievement in Niger State, Nigeria. The research design used was quasi-experimental using pre-test and post-test control group approach. Two research questions and two null hypotheses were formulated. The population of the study consisted of 165,034 SSII Biology students in the twenty-five Local Government Areas of Niger State. The sample size consisted of 100 SSII Biology students from two selected senior secondary schools in Tafa Educational Zone. The instruments for data collection were 30-item Biology Achievement Test (BAT) validated by experts. Split half method was used to establish the reliability of BAT and the results obtained gave the reliability coefficient $r = 0.85$. Descriptive statistics were used to answer the two research questions, while ANCOVA was used to test the null hypotheses. The results of the analysis showed that there was significant difference in students' academic achievement in Biology between those exposed to sequential teaching methods and their counterparts taught with conventional method. It was also shown that there was no significant difference in students' academic achievement of male and female taught Biology using sequential teaching methods. The research concluded that sequential teaching method has positive effect on students' academic achievement and is gender friendly. It was recommended among others that: regular workshops, seminars and conferences should be held for Biology teachers to make them familiar with the knowledge of sequential teaching methods and should be encouraged to use it in their classroom teaching and learning.

Keywords: Sequential Teaching Methods, Achievement, Gender and Biology

Introduction

Education is a foundation for development and progress of any society. It is a base upon which the whole building of human development stands. Getting proper education is necessary for success in life just like the food is necessary for the healthy body. Education leaves long-lasting impact on global development. Science has a unique nature. It is an organized body of knowledge in form of concepts, laws, theories and generalizations. Ugbong (2016) defined science as a study of nature and natural phenomena in order to discover their principles and laws. Science enhances national development and also exposes an individual to recent ideas through reasoning and mental efforts (Orji & Anaduaka, 2010). All nations in the world including Nigeria are striving hard to improve or develop technologically and scientifically. This could be achieved through laying a solid foundation in science and technology studies. Science as school subjects comprises of Physics, Chemistry, Mathematics, Agriculture and Biology. Of all Biology is the only descriptive science which is very much linked to human life unlike Chemistry and Physics which are quantitative in nature. Science Education is defined as the study of the connection between science as a discipline and the application of educational principles to comprehend science teaching and learning in the classroom (Dabah, 2016). Therefore, science education acquaints students with certain basic knowledge, skills and attitudes needed for future work in science and science-related fields. The impact of science education on national development could be felt in several ways; as it provides humanity with knowledge about the environment, attitudes and values for social living,

knowledge and skills to explore and transform resources, change in quality of life and improvement in economy (Udofia, 2010).

Biology is one of the core science subjects that senior secondary school students offer in Nigerian secondary schools, it was introduced to students at this level as a preparatory ground for human development, where career abilities are groomed, potentials and talents are discovered and energized (FGN, 2013). It is also a prerequisite for higher learning in a number of science related professional courses like medicine, zoology, botany, biochemistry and microbiology. Biology is very wide with many branches such as genetics, ecology, morphology, evolution and the more advanced cell biology among others. As a natural science subject, Biology studies the living world that is; it deals with the study of living organisms (plants and animals) including their structure, functioning, growth, origin, evolution, distribution and interrelationship growth. It studies life processes of a group or category of living organisms. A lot of reasons are borne in mind while studying Biology. These include among others, the understanding of self and the environment surrounding us, appreciation of nature as well as pollution control. Thus, Biology and its study are necessary not only for students but the whole of human populace as well as its achievement.

Academic achievement is the extent to which a student, teacher or institution has been able to achieve their educational goals (Okeke, 2011). Hornby (2015) defines achievement as a thing that somebody has done successfully especially using their own efforts and skills. There are conflicting reports in the literature concerning the effect of teaching strategies on students' achievements. Lawal, (2011) opined to this fact that another trigger of poor achievement in Biology is ineffective teaching method because most teachers resolve to the use of talk-chalk method or lecture method because it saves time, gives wider coverage of syllabus, less tedious and so on. Other factors have been identified by researchers as being responsible for the decline and poor achievement of students in Biology; some of these include; lack of qualified teachers, lack of educational facilities like laboratories, overloaded syllabuses, laziness, poor attitude and lack of interest on the part of the students, large class size, family/home background of the students (Osuafor & Okonkwo, 2013). Based on this premise, sequential usage of three teaching methods was applied: demonstration, discussion and conventional (talk-chalk) in teaching Biology content in a sequence of use in order to ascertain their effects on students' achievement and retention.

Sequence is an act of putting events, ideas, and objects in a logical order (Frank, 2013). Sequential teaching method is an instructional method that engages students to learn a particular topic in logical order of display or is a process of imparting knowledge to learners using different instructional methods in logical order. It provides a concrete basis for conceptual thinking (promoting critical thinking skills). Demonstration method involves the use of instructional materials to show learners how something is done in order to enable them acquire skills necessary for performing the given task. The method is mostly used in showing the students correct use of certain science equipment. Demonstration can be carried out as: teacher centred approach, quasi student centred approach or student centred approach. The method encourages students' participation which is necessary for effective teaching. It is a strategy that focuses on achieving psychomotor and cognitive objectives (Azubuike & umuni, 2018).

Discussion method involves a group of people in a class who come together to exchange ideas, facts, opinions and expressions orally about a topic of mutual concern and interest under a guide. In a discussion class, the students talk to each other about the concept or problem until there is an agreeable understanding to it mentally. This method encourages children to be independent of teacher and discover knowledge and also see relationship on their own. The discussion method involves intelligent exchange of views, ideas and opinions on a topic, which covers a wide range of classroom activities and interactions or it involves written and oral expression of different points of view in a given situation (Cashin, 2011). The lecture method (talk-chalk) is concerned with the teacher being the controller of the learning environment. It does not encourage deeper students' involvement as they are passive recipient of information already acquired by the teacher. Also, it does not facilitate the development of reasoning skills and processes in the students. These among other reasons had not enhanced learning in students and thus had led to poor achievement and retention of Biology concepts among students in secondary schools (Merriam & Grace, 2011).

The intervening variable influencing students' achievement in Biology at SSCE is gender. Gender is a social construct that differentiate male from female based on physical features. Many researchers (Apochi, 2017, Nneka, 2015; Abdul-Raheem, 2012 & Okoro, 2011) have shown gender to be of significant influence in an investigation of this

nature, hence the inclusion of gender as an intervening variable in this study. In this study, therefore, the effect of sequential teaching methods (STM) on senior secondary school Biology students' achievement was investigated.

Education is an indispensable instrument for the development of any nation and teachers are the implementers of the educational programme and theories into practice. The teaching of science particularly Biology should be consistent with the nature of science which lays greater emphasis on engaging students in inquiry activities as the use of one-size-fits-all curriculum no longer meets the needs of majority of learners. However, due to the usefulness of biology in nearly all fields of human endeavor, the poor achievement of students at senior secondary schools level is of significant concern to stakeholders in education. In addition, Biology teachers use talk-chalk/lecture method to teach the subject, which does not in any way provide sequence of learning experience that is, the talk-chalk/lecture method is imperfect because it involves verbal presentation of pre-planned lesson to the students which requires little or no instructional aid and so does not promote students' higher level of thinking (Dajal & Mohammed, 2019). More so, the persistent use of this method makes students passive rather than active learners and does not promote insightful learning and long-term retention of some abstract concepts in biology (Umar, 2011). Therefore, considering the importance of biology in all round development there is need for change in strategy/method of teaching so as to enable students in senior secondary schools to acquire adequate knowledge and skills in science. In the same vein, researchers in science education especially Biology have always been searching for better teaching method that will enhance better students' achievement and promote their attitude so that they perform well in Senior Secondary School Certificate Examinations. Hence, the needs to improve on the teaching and learning of Biology by exploring using an innovative learner-centred method like sequential teaching methods.

Purpose of the Study

The general purpose of this study was to investigate the effects of sequential teaching methods on senior secondary Biology students' achievement.

Specifically, the objectives of the study were to:

- i. compare the academic achievement scores of students taught Biology with sequential teaching methods and those taught with conventional method;
- ii. determine the mean achievement scores of male and female students taught Biology with sequential teaching methods.

Research Questions

The following research questions were raised to guide this study:

1. What are the academic achievement scores of students taught Biology with sequential teaching methods and those taught with conventional method?
2. What are the mean achievement scores of male and female students taught Biology with sequential teaching methods?

Research Hypotheses

The following null hypotheses were formulated for the study and tested at significant level of 0.05.

H₀₁: There is no significant difference in the mean achievement scores of students taught Biology with sequential teaching methods and those taught with conventional method.

H₀₂: There is no significant difference in the mean achievement scores of male and female students taught Biology with sequential teaching methods.

Methodology

The research design for this study was quasi-experimental that specifically, applied pre-test and post-test non-equivalent control group. Being an experimental study, the samples for the studies were grouped into experimental and control groups. The experimental group was taught biology concepts using sequential teaching methods while the control group was taught the same biology concept using conventional talk-chalk method. Intact classes were used in order to avoid distortion on the normal class settings using the school timetables. The design is presented symbolically in Table 1.

Table 1: Representation of Research Design

Group	Pre-test	Treatment	Post-test
Experiment	O ₁	X ₁	O ₂
Control	O ₁	-	O ₂

Where: O₁ = Pretest
X₁ = Treatment of experimental group
O₂ = Post-test

The population of the study comprised of all the one hundred and sixty-five thousand and thirty-four (165,034) SSII Biology students in the twenty-five Local Government Areas of Niger state (Computer statistics, Niger State Ministry of Education). One hundred sample size formed in this study was selected using purposive sampling technique. Multistage sampling technique was used in selecting the Local Government Area and schools for the research. At first stage, simple random sampling was used to select one Local Government Area from the twenty-five (25) Local Government Areas in Niger state. The reason for the choice of simple random sampling technique is to give each Local Government Area equal chance of being selected in the study. At the second stage, two co-educational secondary schools were selected using simple random sampling technique. The choice of co-education schools was because gender is one of the variables in the study. At the third stage of sampling, one intact class of Biology students in SSII from the two sampled schools was selected randomly (hat-draw method) and the two classes were assigned experimental group and control group.

The instruments used for data collection in this study were Biology Achievement Test (BAT) and Lesson plan. Biology Achievement Test (BAT) was used as pre-test and post-test in the study. It consisted of two sections: Section A and Section B. Section A entails the general information of the students while Section B entails the Biology Achievement Test questions (Appendix V). The BAT comprised of thirty (30) items multiple choice objective test questions with four (4) options lettered A, B, C and D. The test items were based on concepts in ecological management: association, tolerance, adaptation, pollution, nutrients cycling in nature, basic ecological concepts, population studies and conservation of natural resources adopted from past West African Examination Council (WAEC, 2010-2015 standardized questions). The researcher prepared a table of specification (Test blue print) to guide the test development, in accordance to the senior secondary curriculum. The researcher prepared two sets of lesson plans for teaching both experimental and control groups for each topic that was taught; each unit contained eight lessons that lasted for eight weeks. One set of lesson plan was prepared using sequential teaching methods while the other set was prepared based on conventional method.

The Biology Achievement Test (BAT) was subjected to scrutiny by four experts in the subject area and was content validated using table of specification and face validation by experts in the Department of Science and Environmental Education, University of Abuja; and two Biology teachers from sampled senior secondary schools in Tafa LGA, Niger state. The comments and recommendations of the experts had helped in selection and modification of the test items for the study. After the validation, the BAT items were subjected to Split half reliability estimate. A split half method was used to compute the reliability of the Biology Achievement Test. It was administered once and the scores were divided into two to calculate the reliability of the instrument. A method of estimating reliability involved twenty-five (25) senior secondary II Biology students (15 male and 10 female). Pearson Product Moment Correlation Coefficient (r) was used to calculate the internal consistency of the BAT. This method of estimating the internal consistency reliability of an instrument is appropriate for dichotomously scored items such as BAT which is a multiple choice objective test with right and wrong answers and is easier to use. The outcome of the reliability estimate warranted modifications in the test item (BAT). The reliability coefficient of the instrument gave $r = 0.85$. Thus, BAT was considered reliable. The treatment lasted for a period of eight weeks of treatment, BAT instrument was administered as pre-test for both experimental and control groups; after the first week, the researcher went round the sampled schools and taught students personally for eight (8) weeks during their lesson period using the prepared lesson plans and notes was given. The researcher administered the BAT post-test. The data collected were analyzed accordingly.

Results

The Data obtained were analyzed using descriptive statistics frequent counts, mean and standard deviations for the research questions while the hypotheses were tested at 0.05 level of significance using ANCOVA.

Research Question One:

What are the academic achievement scores of students taught Biology with sequential teaching methods and those taught with conventional method?

Table 2: Mean and standard deviation showing achievement scores of students taught Biology with sequential teaching methods and conventional method

Treatment Groups	N	Pre-test	Post-test	Mean Difference
		X Sd.	X Sd.	
Sequential Teaching Methods (Experimental)	51	27.441.00	39.9410.22	12.50
Conventional Method (Control)	49	21.863.55	26.5441.38	4.680
Total	100			

In Table 2, the mean scores of the students in the sequential teaching methods (experimental group) on pre-test and post-test are 27.44 and 39.94 respectively. These results give a post-test - pre-test mean difference of 12.50; while those of the students in conventional method (control group) are 21.86 and 26.54 respectively, giving a post-test - pretest mean difference of 4.68. The gains in scores show that the students in the experimental group taught sequential teaching method (13.40) performed better than their counterparts in conventional method (5.58). Considering the research question one - what are the academic achievement scores of students taught Biology with sequential teaching methods and those taught with conventional method? - The observations indicate that students taught using sequential teaching method did better than those taught with the conventional teacher-centered method.

Research Question Two:

What are the mean achievement scores of male and female students taught Biology with sequential teaching methods?

Table 3: Mean and standard deviation showing Achievement scores of Male and Female Students taught Biology with sequential teaching methods

Gender	N	Pre-test	Post-test	Mean Difference
		X Sd.	X Sd.	
Male	27	13.541.26	13.560.62	0.02
Female	24	11.410.56	11.420.00	0.01
Total	51			

Table 3 the mean scores of the male students in the sequential teaching methods (experimental group) on pre-test and post-test are 13.56 and 13.54 respectively. These results give a post-test - pre-test mean difference of 0.02; while female students also taught the same instructional strategy are 11.42 and 11.41 respectively, giving a post-test - pretest mean difference of 0.01. The gains in scores showed that both genders taught sequential teaching method had 2.14 and 2.13 respectively. A comparison of these achievements indicates that both male and female in sequential teaching methods had better achievements. These observations answered the question two - what are the mean achievement scores of male and female students taught Biology with sequential teaching methods?

Hypotheses testing

H_{01} : There is no significant difference in the mean achievement scores of students taught Biology with sequential teaching methods and those taught with conventional method.

Table 4: Summary of Analysis of Covariance (ANCOVA) of Biology Students taught using Sequential Teaching Methods and Conventional Method

Source of Variation	Type III Sum of squares	df	Mean square	F.cal	Sig.	Decision at p<.05
Corrected Model	7681.545 ^a	3	3240.512	91.634	.000	S
Intercept	3762.004	1	3762.006	113.240	.000	S
Covariate Pre-test	185.17	1	185.17	3.330	.061	Ns
Methods	6863.206	1	3286.807	134.331	.000	S
Error	3173.710	129				
Total	119631.000	133				
Corrected Total	9766.276	132				

a. R Squared = .677 (Adjusted R Squared = .671)

Table 4, reading on the row Methods revealed that Mean Square = 6863.206, F = 134.331, df = 1 and Sig. = .000 = p. Since p < 0.05, the noted difference between achievement scores of students taught using sequential teaching methods and conventional method is significant. So, the null hypothesis was rejected with the conclusion that there is a significant difference between the mean achievement scores of the students taught using sequential teaching methods and those taught Biology with conventional method.

H_{02} : There is no significant difference in the mean achievement scores of male and female students taught Biology with sequential teaching methods.

Table 5: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students taught Biology using Sequential Teaching Methods

Source of Variation	Type III Sum of squares	df	Mean square	F.cal	Sig.	Decision at p<.05
Corrected Model	65.457 ^a	2	32.539	.681	.462	ns
Intercept	3036.640	1	3036.640	70.231	.000	s
Covariate Pre-test	52.027	1	52.027	1.203	.277	ns
Sex	6.483	1	6.483	.156	.802	ns
Error	3023.610	70				
Total	86481.000	73				
Corrected Total	3081.276	74				

a. R Squared = .678 (Adjusted R Squared = .672)

Table 5, reading on the row heading Sex, revealed that Mean Square = 6.483, F = .156, df = 1 and Sig. = .802 = p. Since p > 0.05, the note in the difference of students taught using sequential teaching methods between male and female students is not significant. So, the null hypothesis was not rejected with the conclusion that there is no significant difference between the achievement scores of male and female students taught Biology using sequential teaching methods.

Discussion of Findings

The first findings revealed that students taught biology using sequential teaching methods achieved significantly higher than those taught using conventional method. This finding is in agreement with Namasaka, Helen & Chrilukovian (2017) who said that sequential teaching methods are an effective method of teaching because it helps students acquire

useful knowledge. Similarly, Ajaja(2013), Selviana &David (2017) said that sequential teaching methods experiences enhanced students' understanding of process of science, improved students' attitude towards biology and significantly influenced their Biology achievement. However, the results of these findings negate that of Azubuike &Mumuni (2018), who asserted that there was no significant difference in the mean scores achievement of students. Furthermore, the second findings revealed that male and female students taught biology using sequential teaching methods performed better equally that is, there was no significant difference in their mean achievement scores. This finding agreed with Mbaegbu, Chioma & Osuafor (2012), who underscores sequential teaching methods as gender friendly. In a similar study by Dajal & Mohammed, (2019) recorded no significant difference in male and female students in experimental group. This is so because the learner centered method promote and encourage active engagement in learning and self-motivation can be easily achieved.

Conclusion

This research investigated the effects of sequential teaching methods on senior secondary school Biology students' achievement in Tafa, Niger State. The result revealed that students taught STM are more motivated to learning Biology. Also, the students are more enhanced to taking responsibility of their own learning than those taught by the conventional method. Gender has no significant effect on students' achievement. This study finally concluded that the use of sequential teaching methods was innovative, resourceful and would be a good asset to Biology teachers and students. Based on the finding of the study, sequential teaching methods enhance student's achievement due to its stimulation of attention or curiosity in the students by making them desirous to learn and know biology. This finding makes the researcher to conclude that sequential teaching methods are elegant to students' achievement and gender friendly.

Recommendations

Based on the findings in this study the following recommendations were made:

1. Biology teachers in schools should be encouraged to use sequential teaching methods in teaching other concepts
2. Teacher education institutions are encouraged to include sequential teaching methods in their biology curriculum for training and retraining in workshops, seminars, etc.
3. Textbook writers should be encouraged to incorporate sequential teaching methods in their writings. This will go a long way in making biology teachers more educated about the approach.

References

- Abdu-Raheem, B.O. (2012). The Influence of Gender on Secondary School Students' Academic Performance in South-West, Nigeria. *Journal of Social Science*, 31 (1), 93-98.
- Ajaja, O.P., (2013). Concept Mapping As a Study Skill: Effects on Students Achievement in Biology, Delta State University, Abraka, Nigeria. *Electronic Journal of Science Education*, 17(1).Retrieved from ejse.southwestern.edu.
- Apochi, M.A. &Abubakar, Z. (2017).The use of Learner Engagement in Science Curriculum Delivery. *Palgo Journal of Education Research*, 5(4), 298-302. Retrieved from <http://www.palgojournals.org/PJER/Index.htm>
- Azubuike, E.N. &Mumuni, A.A. (2018).*Effects of Teaching Strategies (demonstration and guided inquiry) on Biology Achievement of Secondary School Students with different Learning Styles (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) in Rivers State. Journal of Research & Method in Education (IOSR-JRME)*; 8 (2), 01-20. Retrieved from www.iosrjournals.org.
- Cashin, W.E. (2011). Effective Classroom Discussions. Idea paper No 49, Idea Centre, Kansas State University.
- Dabah, J. A. (2016). Science Education in Nigeria Theory and Practice. Calabar: TheodaPublishers.
- Dajal, R.G. & Mohammed, A.U. (2019). Effects of Guided Discovery Method on Students' Attitude to, and Achievement in Biology in Senior Secondary Schools, Bauchi State. *International Journal of Research and Scientific Innovation (IJRSI)*, 6(7), 105.Retrieved from www.rsisinternational.org.
- Federal Government of Nigeria, FGN.(2013). *National Policy on Education*. Lagos: NERDC Press.
- Frank, E. (2013). In order to learn: How the Sequence of topics Influences Learning. Oxford series on Cognitive Models and Architectures. New York: Oxford University Press.
- Hornby, A.S. (2015). Oxford Advanced Learner's Dictionary.9th Ed. New York: Oxford University Press.

- Lawal, F.K., (2011). Biology Teachers' Perception of the Senior Secondary School Biology Curriculum and the need for Reform. Science Teachers' Association of Nigeria (STAN) 52nd Annual.
- Mbaegbu, C.S., Osuafor, M.A. & Akachukwu, E.E. (2020). Effects of Sequential Usage of Three Teaching Methods on Academic Achievement of Senior Secondary students in Biology. *Journal of Research & Method in Education (IOSR-JRME)*, 10(2), 49-56. Retrieved from www.iosrjournals.org.
- Merriam, S.B. & Grace A.P. (Eds.), (2011). *The Jossey-Bass reader on contemporary in Adult Education*. San Francisco.
- Namasaka, F.W., Mondoh, H.O. & Chrilukovian B.W. (2017). Effects of Sequential Teaching Methods on Retention of Knowledge in Secondary Student Biology in Kenya. *European Journal of Education Studies*, 3(5). Retrieved from www.oapub.org/edu.
- Nneka, R.N., (2015). Effect of Cooperative Learning Instructional Strategy on Senior Secondary School Students' Achievement in Biology in Anambra State, Nigeria. *International Journal for Cross-Disciplinary Subjects in Education (IJCDSE)*, 5(1).
- Okeke, O.J. (2011). Effects of Mind Mapping Strategy on Students' Achievement, Interest and Retention in Senior Secondary Schools Chemistry. Unpublished Thesis submitted to the Department of Science Education, Faculty of Education, University of Nigeria, Nsukka.
- Okoro, A.U. (2011). Effect of Interaction Patterns on Achievement and Interest in Biology among Secondary School Students in Enugu State Nigeria. (Unpublished Master's Thesis), University of Nigeria, Nsukka.
- Orji, A.B.C. & Anaduaka U. (2010). Effect of Webbing Instructional Strategy on Students Achievement in Algebraic word Problems. *Journal of Research in National Development*, 8(2).
- Osuafor, A. & Okonkwo, G. (2013). Influence of Family Background on Academic Achievement of Secondary School Biology Students in Anambra State. *An International Multidisciplinary Journal, Ethiopia*, 7(3), 156-167.
- Selviana N. & David B.M. (2017). Developing Students' Research Proposal Design through Group Investigation Method. *IOSR Journal of Research & Method in Education (JRME)*, 7, 1(1).
- Udofia, T.M. (2010). "Science, Technology and Mathematics Education: The Panacea for Economic Meltdown in Nigeria". **51st STAN Annual Conference Proceeding**.
- Ugbong, J.C. (2016). *Methodology of Science Teaching*, Calabar; Dolink Publishers.
- Umar, A.A., (2011). Effects of Biology Practical Activities on Students' Process skill Acquisition in Minna, Niger State, Nigeria. *Journal of Science, Technology, Mathematics and Education (JOSTMED)*, 7(118-126).
- West African Examination Council (WAEC), (2010-2015). *Chief Examiners' Reports, Lagos*.
- West African Examination Council (WAEC), (2017-2020). *Chief Examiners' Reports, Lagos*.