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Effects of Sequential Usage of Three Teaching Methods on Academic Achievement of Secondary School Students in Biology in Onitsha Education Zone

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Abstract:*The study investigated the effects of sequential usage of three teaching methods on the academic achievement of senior secondary school students in biology. Four research questions and four hypotheses guided the study. The quasi-experimental design, specifically the pretest posttest nonequivalent group design was used. A sample of 154 Senior Secondary School year two (SS 2) biology students from Onitsha Education Zone of Anambra State were involved in the study. The instrument for data collection was Biology Achievement Test (BAT) validated by three experts. The reliability of the instrument was established using Kuder-Richardson Formula 20 which yielded coefficient of internal consistency of 0.94. The treatment involves exposing the three groups of students to the biological concept of osmosis and diffusion using a combination of three teaching methods presented in three different sequence. The data obtained were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The results showed that a significant difference exists in the mean achievement scores of students in the experimental groups, in favour of demonstration-laboratory students' experiment and lecture sequence (DEL). No significant difference existedbetween the mean achievement scores of male and female students in the three sequences. The researcher recommended that state government should organize seminar, workshops and orientation exercise to familiarize basic science teachers on how to use students' laboratory experiment as well as conduct good demonstration of concepts to enhance meaningful understanding.*

Keywords: *sequential usage, achievement, teaching methods, osmosis*

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I. Introduction

Biology is a natural science that studies the living world. It is a prerequisite subject for many fields of learning that contributes immensely to the technological growth of the nation. A lot of reasons are borne in mind while studying biology. These include among others, the understanding of oneself and the environment surrounding us, appreciation of nature as well as pollution control. Sound theoretical and practical knowledge of biology according to Johnson (2005) is very necessary for proper management of natural resources and maintenance of good healthy living habits. Thus, biology and its study are necessary not only for students but the whole of human populace.

Despite the importance and popularity of biology among Nigerian students, it is very disappointing to note that students' performance in the subject at both internal and external examinations has remained consistently poor (Osuafor&Okonkwo, 2013). Okoro (2011) asserted that for some years the percentage of students who obtained credit pass in biology at West African Senior School Certificate Examination (WASSCE) in Nigeria has been low and their performance is poor. In Onitsha education zone in Anambra State, statistics from May/June 2011-2015 for senior secondary certificate examination showed the percentage of candidates who passed WASSCE at credit level and above in biology as follows; 65.7% in 2011, 34.9% in 2012, 69.3% in 2013, 76.8% in 2014 and 65.6% in 2015 (Source: Planning, Research, and Statistics Department, Post-primary Education Board, Onitsha, 2016). The trend although showed some improvement in the subject, but the performance of students fluctuates with a decline in 2012 and 2015. This evidence indicates thatsecondary school students' academic achievement in Biology is still not at its best. If the grades that students get at the end of a course of study continue to either fluctuate or sometimes decline, the implication is that Nigeria may have inconsistent supply of manpower or facility for teaching science and technology related disciplines. This may affect Nigeria's vision to become one of the 20 industrialized nations in the world by year 2020. These have raised research interest in order to understand the factors responsible for fluctuations and decline in students achievement as well as poor students' achievement and proffer solutions to them.

Many factors have been identified by researchers as being responsible for the decline and poor performance of students in biology. Some of these include; lack of 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). Apart from these factors, poor teaching methods adopted by teachers at senior secondary school level in Nigeria have also been identified as one of the major factors contributing to poor performance of students in biology (Ahmed &Abimbola, 2011; Umar, 2011; Wanbugu, Changeiywo&Ndritu, 2013). If students are not happy with the way biology is taught, they may show disinterest and negative attitudes in and towards biology and its teaching and this would affect their achievement in biology.

Another issue on the poor achievement in biology is the notion of some male students that biology is a subject for the females and not for the males. Some research works have shown contradictory evidence in student's academic achievement in science due to gender (Ogbaga, 2016). Ifeakor (2003) found out that there was no statistical significant difference in the achievement of male and female students in biology and chemistry respectively. The teaching methods adopted for teaching biologyhave been observed to be gender biased. Therefore, one can emphatically state that by the virtue of the importance of biology as a school subject, there is need for its effective teaching and learning to bring about good achievement in both male and female students.

The teaching of science particularly biology should be consistent with the nature of science which lays greater emphasis on engaging the students in inquiry activities. The use of one-size-fits-all curriculum no longer meets the needs of the majority of learners. The use of a single-paced lesson delivered through a singular instructional approach disregards the different learning styles and interest present in allclassrooms. It is important to point out that every learner benefits from an engaging learning experience, deserves to be treated with respect and should have an opportunity to reach his or her potential. According to Arubayi (2009), the current educational system does not adequately address these needs. Thus, it becomes pertinent to look for interventions that could be manipulated in order to find their effects on learning outcomes. Such attempts could address the problems of teaching and learning of biology in schools. Based on this, the researcher applied a sequential usage of three teaching methods: lecture; demonstration and laboratory student experiment in teaching biology unit four of SS2 biology content and varied the sequence of use in order to ascertain their effects on students' achievement.

Sequence is an act of putting events, ideas, and objects in a logical order (Frank, 2007).Lecture (expository) method of teaching is a teacher-centered, student-peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials (Okigbo, 2010). Lecture method is often used to deliver a large amount of information to the students in a short period. According to Gehlen-Bauum and Weinberger (2014), lectures are designed to deliver new information to a large group of students. This method is known to be effective in dealing with a large class. Research also shows that teaching method like the lecture method commonly used by teachers does not help the students to acquire sufficient functional understanding. In the lecture method, the teacher tells the students what to do instead of activating them to discover for themselves. In view of these limitations of lecture method, Ameh and Dantani (2012) advocated for demonstration method.

Demonstration as a teaching method is where the teacher shows how something is done by actually doing it. Demonstration is a useful method of teaching because it improves students' understanding (McKee, Williamson&Ruebush, 2007). According to Al-Rawi (2013), demonstration is effective in teaching skills of using tools and laboratory experiment in science, it also has the advantage of being a good way of motivating students to learn and also believed to save time and materials as well as show how to avoid breakages and accidents. . However, the time available to perform this demonstration is very limited in a classroom setting. Therefore, a demonstration is designed to allow students to make observations rather than hands-on practical work. With regard to these flaws of demonstration method, there is a need for another method of teaching that can provide students with the time, environment or settings that will enable them to develop skills and manipulation needed for carrying out activities on their own. One of such methods is laboratory student experiment.

The laboratory is an indispensable tool in the teaching of science which provides students with a place or setting to attack and solve problems, collect data, prove ideas and carry out investigations which emphasizes learning by "doing". Arubayi (2009) opined that the laboratory method of teaching comprised of a variety ofactivities ranging from the experimental investigations to confirmatory exercises and skill learning. Arubayi (2003) summarized the major objectives sought in laboratory work, as the development of skills, concepts, cognitive abilities and understanding of the nature of science. It also helps to develop some desired traits such as appreciation which are necessary for problem solving and skill acquisition. Unfortunately, the laboratory method cannot be effectively used without demonstration method which is useful in teaching skills of using tools and laboratory experiment in science and lecture method which are often used to introduce new lessons to

a group of students.As in other lessons, in science lessons, the effectiveness is related to the use of teaching methods. Some methods may be used together for delivering a topic but, the question of which method must take precedence to increase students' academic achievement in biology is yet to be ascertained. Finding an answer to this is the focus of this study.

Purpose of the Study

The general purpose of this study was to determine the effects of sequential usage of three teaching methods on the academic achievement of senior secondary school students in biology.Specifically, the study determined the:

1. Mean gain achievement scores of biology students exposed to lecture, demonstration and laboratory methods of teaching presented in three different sequences.
2. Difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Lecture- Demonstration-laboratory students' Experiment (LDE).
3. Difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Demonstration- laboratory students' Experiment- Lecture (DEL).
4. Difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of laboratory students' Experiment-Lecture- Demonstration (ELD.)

Research Questions

The following research questions guided the study.

1. What are the mean gain achievement scores of biology students exposed to lecture, demonstration and laboratory methods of teaching presented in three different sequences?
2. What is the difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Lecture-Demonstration- laboratory students' Experiment (LDE)?
3. What is the difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Demonstration-laboratory students' Experiment- Lecture (DEL)?
4. What is the difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of laboratory students'Experiment- Lecture- Demonstration (ELD)?

HYPOTHESES

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean gain achievement scores of biology students exposed to lecture, demonstration, laboratory methods of teaching presented in three different sequences.
2. There is no significant difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Lecture-Demonstration- laboratory students' Experiment (LDE)
3. There is no significant difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Demonstration- laboratory students' Experiment- Lecture (DEL)
4. There is no significant difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of laboratory students' Experiment- Lecture- Demonstration (ELD).

II. Method

The design of this study is quasi-experimental.The area of study was Onitsha Education Zone of Anambra State.The population of the study was made of 2,646 senior secondary school year two (SS2) biology students (1465 males and 1181 females) found in the 19 state-owned co-educational schools within Onitsha education zone of Anambra State.The sample for the study comprised 154 senior secondary year two (SS2) biology students. The sampling technique used was a multistage procedure. Biology Achievement Test (BAT) developed by the researcher was used as instrument for the study.The BAT questions were constructed based on the two topics used in the research. The test was made up of 20 multiple choice questions drawn using a table of specification to make sure that the content areas taught were adequatelycovered. The lesson plans were designed using three different sequence of instruction with lecture, demonstration and laboratory methods of instruction for each lesson in the different experimental groups. The instrument was validated by three experts. The reliability of the instrument BAT was established using the Kudder-Richardson formula twenty (KR-20) method.The coefficient of reliability obtained was 0.94.

The procedure for the treatment involved exposing the students to the biological concepts of diffusion and osmosis using a combination of three instructional approach presented in different sequences. The research have three groups of students, each had three lessons which lasted six weeks. The various sequence that was used for teaching are: for experimental group 1, Lecture, Demonstration, and Laboratory students' experiment (LDE), for group 2, Demonstration, Laboratory students' experiment and Lecture (DEL), and for group 3, Laboratory students' experiment, Lecture and Demonstration (ELD). For each lesson which shall last for 120

minutes (one double period in one week and single period in the following week), these sequences were followed in each treatment group.

The research questions were answered using mean. The hypotheses were tested at 0.05 level of significance using Analysis of covariance (ANCOVA). In the cases where there are significant effects of the treatment, a post-Hoc test using the Scheffe's method was used to determine the direction of the significance. The decision rule was: reject null hypothesis if probability value (P-value) is lesser than 0.05, otherwise do not reject the null hypotheses.

III. Result

Research Question 1: What are the mean gain achievement scores of biology studentsexposed to lecture, demonstration and laboratory methods of teaching presented in three different sequences?

Table 1: Mean gain achievement scores of the treatment groups

Groups	N	Mean pre-test	Mean post-test	Mean gain score
LDE	54	33.15	51.76	18.61
DEL	47	41.70	64.79	23.09
ELD	53	38.21	55.28	17.07

Table 1 shows that the LDE sequence group had a mean gain score of 18.61 and achieved higher than those in the sequence group of ELD with a difference of 1.54. The group taught using the sequence of DEL had a mean gain score of 23.09 compared to the group taught with the sequence of ELD with a mean gain score of 17.07. Also the DEL group achieved higher than LDE sequence group with a mean difference of 4.48. Those in the DEL group had the highest mean gain achievement score.

Research Question 2: What is the difference in the mean gain achievement scores ofmale and female students in biology exposed to the teaching sequence of lecture-demonstration and laboratory students' experiment (LDE)?

Table 2: Mean gain achievement scores of male and female students taught using LDE sequence

Gender	N	Meanpre-test	Mean post-test	Mean gainscore	Meandiff
Male	27	33.70	50.37	16.67	3.89
Female	27	32.59	53.15	20.56	

Table 2 shows that the mean gain score in the achievement of the male students exposed to the teaching sequence of LDE is 16.67 while the females had a mean gain achievement score of 20.56. The difference in their mean gain is 3.89 in favour of the females.

Research Question 3: What is the difference in the mean gain achievement scores ofmale and female students in biology exposed to the teaching sequence ofDemonstration-laboratory students' Experiment- Lecture (DEL)?

Table 3: Mean gain achievement scores of male and female students taught using DEL sequence

Gender	N	Meanpre-test	Mean post-test	Mean gainscore	Mean diff
Male	34	40.74	66.77	26.03	10.64
Female	13	44.23	59.62	15.39	

Table 3 shows that the mean gain score in the achievement of the male students exposed to the teaching sequence of DEL is 26.03 while the females had a mean gain achievement score of 15.39. The difference in their mean gain is 10.64 in favour of the males.

Research Question 4: What is the difference in the mean gain achievement scores ofmale and female students in biology exposed to the teaching sequence of laboratory students' Experiment, Lecture and Demonstration (ELD)?

Table 4: Mean gain achievement scores of male and female students taught using ELD sequence

Gender	N	Meanpre-test	Mean post-test	Mean gainscore	Meandiff
Male	37	38.38	55.81	17.43	1.18
Female	16	37.81	54.06	16.25	

Table 4 shows that the mean gain score in the achievement of the male students exposed to the teaching sequence of ELD is 17.43 while the females had a mean gain achievement score of 16.25. The difference in their mean gain is 1.18 in favour of the males.

Hypothesis 1: There is no significant difference in the mean gain achievement scoresof biology students exposed to lecture, demonstration and laboratory methods ofteaching presented in three different sequences.

Table 5: Analysis of Covariance of students' mean gain achievement scores in biology by method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5527.822[a]	3	1842.607	13.014	.000
Intercept	27868.434	1	27868.434	196.832	.000
Pretest	1038.735	1	1038.735	7.336	.008
Method	3057.465	2	1528.732	10.797	.000
Error	21237.762	150	141.585		
Total	526200.000	154			
Corrected Total	26765.584	153			

Table 5 shows that there was a significant main effect of the treatment which accounted for 20 percent of the variance in the achievement scores of the students, F (2,= 10.797, P (0.000) <0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean gain achievement scores of biology students exposed to lecture, demonstration and laboratory methods of teaching presented in three different sequences.

Table 6: ScheffePostHoc of the differences in students' mean achievement scores in biology by method

					95% Confidence Interval for	
(I)	(J)	Mean Difference	Std.	Sig.[b]Difference[b]		
Methods	Methods	(I-J)	Error		Lower Bound	Upper Bound
ELD	DEL	-8.674*	2.404	.000	-13.423	-3.924
	LDE	2.321	2.343	.323	-2.309	6.951
DEL	ELD	8.674*	2.404	.000	3.924	13.423
	LDE	10.995*	2.490	.000	6.075	15.914
LDE	ELD	-2.321	2.343	.323	-6.951	2.309
	DEL	-10.995*	2.490	.000	-15.914	-6.075

Table 6 reveals that significant difference exists between the achievement scores ofstudents taught biology using the sequences of demonstration-laboratory students'experiment-lecture (DEL) and laboratory students' experiment-lecture-demonstration(ELD) in favour of DEL. Table 10 also reveals that a significant difference existsbetween the achievement scores of students taught biology using DEL and lecture-demonstration-laboratory-students' experiment (LDE) in favour of DEL. However,table 10 shows that there is no significant difference between the achievement scores ofstudents taught using LDE and ELD. This shows that the two sequence are equallyeffective, the most effective sequence being DEL.

Hypothesis 2: There is no significant difference in the mean gain achievement scoresof male and female students in biology exposed to the teaching sequence of lecture-demonstration and laboratory students' experiment (LDE).

Table 7: Analysis of Covariance for mean gain achievement score of male and female students in LDE sequence

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	851.764[a]	2	425.882	4.615	.014
Intercept	7954.710	1	7954.710	86.205	.000
Pretest	747.597	1	747.597	8.102	.006
Gender	135.288	1	135.288	1.466	.232
Error	4706.107	51	92.277		
Total	150225.000	54			
Corrected Total	5557.870	53			

Table 7 shows that there is no significant difference in the mean gain achievementscores of the male and female students exposed to the teaching sequence of lecture-demonstration and laboratory students' experiment (LDE), F (1, 51) = 1.466, P (0.232)>0.05. Thus, the null hypothesis was not rejected.

Hypothesis 3: There is no significant difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence ofDemonstration-Laboratory students' experiment-lecture (DEL).

Table 8: Analysis of Covariance for mean gain achievement scores of male and female students in DEL sequence

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	326.033[a]	2	163.016	1.051	.358
Intercept	8172.924	1	8172.924	52.714	.000
Pretest	288.577	1	288.577	1.861	.179
Gender	95.561	1	95.561	.616	.437
Error	6821.840	44	155.042		
Total	204425.000	47			
Corrected Total	7147.872	46			

Table 8 shows that there is no significant difference in the mean gain achievement scores of the male and female students exposed to the teaching sequence ofDemonstration-Laboratory students' experiment-lecture (DEL), F (1, 44) = 0.616, P(0.437) >0.05. Thus, the null hypothesis was not rejected.

Hypothesis 4: There is no significant difference in the mean gain achievement scoresof male and female students in biology exposed to the teaching sequence of Laboratorystudents' experiment, Lecture and Demonstration (ELD).

Table 9: Analysis of Covariance for mean achievement score of male and female students in ELD sequence

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	246.538[a]	2	123.269	.661	.521
Intercept	10387.740	1	10387.740	55.703	.000
Pretest	166.097	1	166.097	.891	.350
Gender	47.384	1	47.384	.254	.616
Error	9324.216	50	186.484		
Total	171550.000	53			
Corrected Total	9570.755	52			

Table 9 shows that there was no significant difference in the mean gain achievementscores of male and female students exposed to the teaching sequence of Laboratorystudents' experiment, Lecture and Demonstration (ELD), F (1, 50) = 0.254, P (0.616)>0.05. Thus, the null hypothesis was not rejected. Therefore, there is no significant difference in the mean gain achievement scores of male and female students in biology exposed to the teaching sequence of Laboratory students' experiment, Lecture and Demonstration (ELD).

IV. Discussion

The findings of this study revealed that there is a significant effect of the treatment with sequential teaching on students' achievement in biology. The result of the study revealed that significant difference exists between the achievement scores of students taught biology using the sequences of demonstration-laboratory students' experiment-lecture (DEL) and laboratory students' experiment-lecture-demonstration (ELD) in favour of DEL. The study also revealed that a significant difference exists between the achievement scores of students taught biology using DEL and lecture-demonstration-laboratory-students' experiment (LDE) in favour of DEL. However, there is no significant difference between the achievement scores of students taught using LDE and ELD. This shows that the two sequences are equally effective, the most effective sequence being DEL.

The sequences of DEL being most effective can be explained on the ground that demonstration as a teaching method is where the teacher shows how something is done by actually doing it. The understanding proceeding from the teachers' demonstration facilitates partial understanding that instigates curiosity in the student. Students after observing the teachers; demonstrations tend to evaluate themselves in terms of whether they can replicate what the teacher has done. This self-evaluation arouses the motivation and interest, first in the concept learnt and then the desire to attempt what the teacher has done. An opportunity following after demonstration in which students' can access their ability to repeat what the teacher had done enables proper conceptualization and proper understanding. This is so because the students having tried to repeat the teachers' behaviors and skills emphasized in the course of demonstration, will discover their weaknesses. Their weakness at this point becomes the motivating factor to seek an understanding of the theories underlying what the teacher has done. When students manifest such learning needs, lectures become invaluable. During such lecture, students seem to be led through an exposition of what they crave to know. Lecture at this time deepens their understanding and moves the students to seek further understanding on their own. They may have to try to go through their experiment again cognitively. Cognitive and metacognitive tasks that students engage at such moments ensures meaningful learning than rote learning.

The findings of this study agrees with that of Snezana and Snezana (2016) who reported in their study that students taught using DEL sequence achieved higher in biology than students in the other groups taught with a different sequence. The findings of the study also supports that of Namasaka (2015) who examined the

effects of sequential teaching methods on achievement and transfer of knowledge in biology by secondary school students. Namasaka found out that demonstration, followed by experiment and lecture method was the most effective method for teaching biology. The findings of Esra, Ijlal and Gürbüz.(2009) who investigated sequential teaching methods in biology and their effects in academic achievement also supports the findings of this study. The result of their study indicated that students in DEL sequence performed better than those in LDE sequence of instruction. The conclusion reached by the researchers is that in science teaching, using laboratory student experiment or slide demonstrations at the beginning of the lesson attracts attention and motivation of students whereas using oral-only lecture bores students and make them lose their attention to it.

V. Conclusion

The findings of this study revealed significant positive effect of sequential usage of three teaching methods (LDE, DEL, ELD) on students' achievement in biology in favour of the DEL sequence. The conclusion was that the sequential usage of demonstration-laboratory students' experiment-lecture was the most effective.

VI. Recommendations

The following recommendations are made based on the findings:

1. Biology teachers should be trained on how to effectively master instructional models and combine them in various sequences during lesson presentation especially in the sequence of demonstration, laboratory students' experiment and lecture method.
2. School laboratories should be equipped with adequate laboratory equipment to enable biology teachers and students to experiment concepts relating to biology to facilitate proper conception of biological phenomenon.

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