The Interaction between Teaching   Methods and Students` Mental Capacity and its Effect on Nigerian Secondary Stage Students` Achievement in Biology

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Abstract:

This study determined the interaction between teaching methods and students` mental capacity and its effects on Nigerian secondary stage students` achievement in Biology**.** The study used Quasi experimental research design. Achievement test in Biology was used for data collection. The sample for the study comprised of seventy (70) secondary stage students in one school, Nigeria. The samples were assigned to groups: the experimental (n=35) and the control group (n=35). The experimental group was taught Biology using demonstration method and the control group was taught using the conventional method. Data collected for the study was analyzed using Pearson Correlation coefficient, Descriptive Statistical (Means and standard deviations), Independent - Samples T – Test and Two-way ANOVA. The study revealed that: there is a significant effect of demonstration method on improving students' achievement in Biology. There was significant difference between students with low and high mental capacity in favor of students with high mental capacity. The study recommends that demonstration teaching method should be incorporated into the secondary curriculum in order to promote active participation of students.

Keywords: Demonstration Method, Achievement and Mental Capacity.

Introduction

One of the fundamental goals of teaching in Nigeria is to educate individuals to think positively and contribute to building vital workforces in nation-building. Subjects taught in schools, including science subjects, should help accomplish this goal by determining students' minds and directing them toward productivity.

Biology is an acceptable science subject that is dominant in secondary schools in the country as a means for higher studies in Nigeria. Biology is an innate science that is mean to examine life, living organisms, and associated ideas therewith. It helps students and scholars to value the living world and has to be dealt with for the advancement of diverse superior fields such as medicine, agriculture, biotechnology, and other

health/medical fields (Miya, Danbam, Abdulkareem, Sarkingobir and Yabo, 2023).

Though, numerous significant factors are presently militating the teaching and learning of science subjects in secondary school settings including Biology (Mahajan, 2015, Orakwue & Okigbo, 2023). The main factor affecting the teaching and learning of Biology is the issue of mental capacity. Mental capacity is also referred to as information processing capacity, mental effort, M- power, m space or working memory. It is defined as the highest amount of information, separate chunks or idea that a student can hold in his mind while working on a problem. It is the workbench of the memory system, the cognizant constituent where our thinking occurs and where we try to make sense of our experiences by connecting them to our prior information. (Eggen and Kauchak, 2014).

On the other hand, achievement is an essential academic factor that has been recognized to be inclined by teaching methods. It is the execution of academic goals, the educational outcomes of students, or the degree to which a student, teacher, or instructor has accomplished the stated educational aims (Loretta, 2012). Academic achievement is generally measured through continuous assessment or termly examinations.

Agogo and Naakaa (2013) believed that the causes of mass failure of students in senior secondary school Biology examination included, teacher's methodology, structuring of the curriculum, the concentration of examination questions on few topics, and students' inability to perform enough practical before the examination.

According to Sadiah (2016) demonstration teaching method is anticipated to be used as a form of action to enhance student learning outcomes in science subjects (Natural Sciences). In this method, students are encouraged to talk, argue and exchange opinions with their classmates and group members, and students will formulate ideas and answers from the results of group discussions into written form. It is a teaching method used to communicate an idea with the aid of visual aids such as charts, images, posters, power point, etc. A demonstration is the process of teaching someone how to make or do something in a step-by-step process.

Against this background, this study seeks to examine the interaction between teaching methods and students` mental capacity and its effect on Nigerian secondary stage   students` achievement in Biology.

Statement of the problem

Despite the importance of Biology among other subjects and constant effort to improve teaching and learning Biology by different

scholars, there is a decline in the achievements of students continuously. Many factors have, conversely, been contributing to students' poor performance in Biology. Agogo and Naakaa (2013) believed that the causes of mass failure of students in senior secondary school Biology examination included, teacher's methodology, structuring of the curriculum, the concentration of examination questions on few topics, and students' inability to perform enough practical before the examination.

Study Significance

The significance of the current study can be presented in the following points:

1. Benefit Biology teachers to advance on their teaching method, professional support and assessment thereby improving students' performance, thus enabling the realization of the stated instructional objectives which is the goal of any academic setting.
2. Provide students with the information that the demonstration method will help them to achieve high in Biology and have an increased interest in Biology which will make them to apply for science courses in the University.
3. Ministry of Education will benefit from the finding of this study because it will help them to assess how best demonstration method can be applied and implemented in senior secondary schools that has a greater effect in improving students' performance and science process skills in Biology

Study Delimitation:

- The current study was delimited to: Selected lessons from Biology text book for senior secondary stage one for the academic year (2022/2023). The lessons were Pollution, Association, Tolerance Adaptation and conservation.
- Two group of first grade secondary stage students in one school in Nigeria.
- Study experiment was carried out during the first semester of academic year (2022/2023).
- The study adopted quasi experimental design (pretest posttest for two groups).

Study Aim:

The present study aimed at achieving the following aim:

1. Examine the effect of either teaching method, mental capacity, and the dual interaction between them on the achievement of Nigerian secondary stage students in Biology.

Study Hypothesis:

The current study assumed the following hypothesis:

1. There is no statistically significant effect at the level ($\alpha \leq 0.05$) either teaching method or mental capacity, or the interaction between them on the achievement for the Nigerian secondary stage students in Biology.

Theoretical Framework and Previous Studies

This study is based on constructivism teaching and learning theory propounded by Jerome Bruner (1990). Constructivism is a learning theory that entails how students construct their knowledge based on prior experiences which are exceptional to every student (Singh & Yaduvanshi, 2015). Constructivism is a learner-centred approach rather than teacher-centred where the instructor acts as a facilitator. The main purpose of this learning theory is to involve students in a way that they can construct their own knowledge by connecting it with their prior experiences (Sherma and Poonam 2015). According to Olusegun (2015) the theory is essentially a learning theory which is based on observation and scientific study of how people learn. Students try to connect something new with their prior knowledge by modifying what they think without essentially ignoring the whole of the new information. The charge is shifted from the teacher to the leaner in a constructivism classroom natural setting. Constructivism classroom is not a place where a well-informed person pours subject matter to students who are well thought-out as vacant vessels set to be filled. in such classrooms, students are encouraged to actively engage in the teaching and learning process while the teacher serve as a guide, motivator, facilitator and coach.

Constructivism teaching and learning theory which is otherwise known as genetic epistemology. Acoording to Singh and Yaduvanshi (2015) the theory aid leaner's to discover more on their own since it is learner-centred where students are actively involved in the teaching and learning process. It also helps learners to convey their skills to real life situation.. The theory also helps learners to ask meaningful questions and apply their curiosity to solve problems in their daily lives. (McLeod, 2019) added that constructivism promotes the sense of personal agency as learners have ownership of their learning and assessment.

Onyeka and Okoye (2023) determined the effectiveness of demonstration on students' academic achievement. Quasi experimental research design was employed for the study. Through random sampling technique, seventy-eight senior secondary one students in their intact class were selected and participated in the study. Mathematic achievement test

was used as instrument for collecting data. The reliability coefficient of the instrument was 0.84 which was determined using Kuder-Richardson formula 21. Mean, standard deviation and analysis of covariance were used for data analysis. The study exposed that students that were taught using demonstration method outperform those taught with the conventional method.

Danjuma and Mankilik (2022) examined the effects of demonstration strategy on retention and achievement of senior secondary students in Taraba State, Nigeria. The pre-test, post-test, non-equivalent control group quasi experimental research design was utilized. One thousand five hundred (1500) ss11 students from 32 mixed schools formed the population of the study. A total of 95 ss11 students participated in the study. Periodic table achievement test consisting of 50 multiple choice items was used for data collection. Kuder-Richardson Formula 20 was used to determine the reliability of the instrument. The reliability coefficient was found to be 0.91 which is highly reliable. Analysis of Covariance (ANOVA), mean and standard deviation were used to analyze the data. Demonstration method was revealed to be significantly effective in enhancing retention and achievement.

Ahmed, Ibrahim and Suleiman (2022) explore secondary school students' performance and determine the effectiveness of demonstration–brainstorming. The study adopts pre-test, post-test quasi experimental research design. Twelve thousand seven hundred and seventy SS 11students during the 2017/2018 academic session formed the population. Intact class of eighty (80): 40 male and 40 female students take part in the study. Multiple choices of thirty items were used to collect data. Descriptive statistics (mean and standard deviation) and t test were used to analyze the data. The study established that there was no significant difference in demonstration method based on gender. But in brainstorming method, male students outperformed the female students. Additionally, both group performed significantly better in demonstration method than in brainstorming method.

Loiser and Endne (2022) investigated the effect of demonstration on learning success. The study was conducted in a classroom and it focused on students' performance as a form of outcome that subsist in learners and can be pragmatic. Also shows that these students have engaged in learning activities. The study revealed that demonstration method had significance effects on students' success. The study recommends among others that

should be applied in the classroom during teaching and learning since it was found to enhance students experience and thinking.

Omotayo and Taiwo (2021) investigated the effects of demonstration teaching method on senior secondary school students' academic performance in Biology, Ekiti State, Nigeria. The study used quasi – experimental research design specifically the pre - test, post-test, control group type. The population of the study was ninety-seven (97) Biology students who were selected through multistage sampling technique. Biology performance Test (BPT) was used for data collection. Data collected were analyzed using mean, standard deviation. Inferential statistics of Analysis of Variance (ANOVA) and t-test were used to test the hypotheses. The study revealed that there was a significant difference in the post - test mean scores of students taught with demonstration teaching method and conventional method. The students taught with the demonstration method outperform those taught with the conventional method. The study concluded that demonstration method is a vital constituent in determining the effectiveness of teaching and learning process in the classroom.

Isaac, Bashir, Buba and Thlama (2020) examined the effects of demonstration and lecture methods on academic performance of senior secondary school students' in Biology in Maiduguri Metropolis. The study employed quasi-experimental research design. The participant of the study was 7687 senior secondary school students in Maiduguri Metropolis. The sample consists of 367 students who were selected through stratified random sampling technique. Data were collected using researcher made performance test and aptitude test in Biology. T-test and mean were used for data analysis. The study discovered that demonstration method was more effective in teaching Biology in senior secondary schools in Maiduguri Metropolis, Borno State, Nigeria. In terms of difference, the study shows that there was significant difference between the performance of students who were exposed to demonstration method and those exposed to lecture methods in favor of demonstration method.

Procedures Prior to Conducting the Research Experiment
The procedure included the following:
- Executing the administrative procedure and preparing the study experiment
- The pre administration of the study tools
- Conducting the experiment
- Post administration of the study tools

Research Design

The current study employed the pre-test post-test quasi experimental research design. Two groups of senior secondary school students were selected to form the experimental and the control group. The experimental group was taught using demonstration methods while the control group was taught using the conventional method. Instruments for the research were administered to both experimental and control group. This enabled the researcher to determine their baseline and end line performance in order to ascertain the point of comparison and determine the effect of demonstration teaching method.

Research Population

The population of this study incorporated all senior secondary stage students' in one hundred and five (105) private senior secondary stage schools in Maiduguri Metropolis, Borno State, Nigeria

Research Sample

The research was conducted in Zenith International Secondary School in Maiduguri, Nigeria. The sample of the study was seventy (70) students selected from two sets of year 1 senior secondary stage Biology. The two sets were class A and B, and each of them constitutes 35 students. Class A which is the experimental group was exposed to treatment whereas class B which was the control group was taught using conventional method. Both groups belong to the same educational level.

Table (3): Description of Research Sample

Research groups		Number	School
Experimental	High Mental Capacity	18	Zenith international secondary school, Nigeria
	Low Mental Capacity	17	
	Total	35	
Control	High Mental Capacity	17	Zenith international secondary school, Nigeria
	Low Mental Capacity	18	
	Total	35	

Table (3) above showed that the research sample was divided into two groups: (35) students as experimental group divided into (18) with high Mental Capacity and (17) with low Mental Capacity and (35) students as control group divided into (17) with high Mental Capacity and (19) with low Mental Capacity.

Research Instrument

In other to get the results of the present study, the achievement test was prepared and used by the researcher

Statistical Methods

The following statistical methods were used to analyze the data:
- Pearson Correlation coefficient.
- Descriptive Statistical (Means and standard deviations).

- Independent - Samples T – Test.
- Two-way ANOVA

Preparation of the Achievement Test:

The researcher designed the test in accordance with the following steps:

Purpose of the Test:

One of the aims of the present study is to improve students' academic achievement of senior secondary stage students in Biology. Therefore, an achievement test was prepared as a measuring instrument to examine the students' performance in the pre-test and post-test in Biology.

Analyzing the Unit Content:

These are levels that are considered by the test. The main purpose is to measure the cognitive aspects of students according to bloom's taxonomy. These levels are: Knowledge, Understanding, Application, and higher levels:

Table of Specification

Table of specification otherwise known as test blue print is a road map that help teacher in the evaluation process. The table shows the total number of items to be allocated to each instructional objective, suggest what might be covered under each item and take decision on what types of items to be used. It is the important step in an evaluation plan since it enables the teacher to combine properly the objective and the content areas, bearing in mind the importance and the weight attached to each area (Akem, 2006). it was prepared after analyzing the unit content, determining the number of questions related to each lesson and level of cognitive process, and determining the relative weights of the four cognitive levels (Knowledge, Understanding, Applying and High levels) the lessons of the topic, as well as the relative weights of the lessons of the unit.

The table was constructed according to the following steps:

Relative Weight of Content According to the Page Numbers:

Table (1) Relative Weight of Content According to the Number of Pages

Lesson	Number of Pages	Relative Weight
Association	5	19%
Tolerance	1	3%
Adaptation	5	19%
Pollution	10	37%
Conservation	6	22%
TOTAL	27	100%

Table (1) above shows the relative weight of content according to the number of pages. The relative weight was determined using percentage. The results shows that the total number of pages is 27 and the relative weight is 100%

Relative weight of content according to the number of sessions:
Table (2) Relative weight of content according to the number of sessions

Lesson	Number of Sessions	Relative Weight
Association	2	18%
Tolerance	1	10%
Adaptation	2	18%
Pollution	3	27%
Conservation	3	27%
TOTAL	11	100%

Table (2) shows the relative weight of content according to the number of sessions. The relative weight was determined using percentage. The result shows that the total number of sessions is 11 and the relative weight is 100%.

Arithmetic Mean of the Relative Weights of Each Lesson:
Table (3) Arithmetic mean of the number of pages and number of sessions

Lesson	Relative Weight of the Number of Pages	Relative weight of the Number of Sessions	The Relative Weights Mean
Association	19	18	18%
Tolerance	3	10	7%
Adaptation	19	18	18%
Pollution	37	27	32%
Conservation	22	27	25%
TOTAL			100%

Table (3) shows the arithmetic mean of the relative weights of each lesson. The mean of the relative weight was determined using percentage. The result shows that the relative weight mean of association is 18%, tolerance is 7%, adaptation is 18%, pollution is 32% and conservation is 25%. And the total relative weight mean is 100%.

Table (4)   Number of Questions in each Lesson

Unit	Level of Questions	Knowledge		Understanding		Applying		Higher Levels		Total	Percentage
	Content	No	Total 30%	No	Total 30%	No	Total 20%	No	Total 20%		
	Association	13 25	2	10,11	2	12	1	-	-	5	18%
	Tolerance	26	1	-	-	14	1	-	-	2	7%
	Adaptation	15,20 27	3	1,	1	4,	1	-	-	5	18%
	Pollution	7, ,9	2	3, 21 22	3	2, 23	2	5 8 24	3	10	32%
	Conservation	16	1	6, 17, 28	3	19, 29	2	18, 38	2	8	25%
Total Number of Questions			9		9		6		6	30	100%

Table (4) above revealed the number of questions in each lesson. The total number of questions is 30. The numbers of questions in each levels of Blooms taxonomy were determined using percentage. The four levels in blooms taxonomy are knowledge, understanding, applying and high levels. The results shows that knowledge has (9) questions, understanding has (9) questions, applying has (6) and high levels has (6) questions.

Internal Consistency of the Test

Pearson correlation coefficient was used to estimate the internal consistency of the test. The estimation was done by calculating the correlation coefficients of each item with the total score of the dimension to which it belongs, as well as the dimensional coefficients with the total score of the test. The findings are provided in the table below.

Table (5): Correlation coefficients of the achievement test questions with the total score of the dimensions to which they belong

Knowledge		Understanding		Applying		Higher Levels	
Q. no	*Pearson Correlation*	*Q. no*	*Pearson Correlation*	*Q. no*	*Pearson Correlation*	*Q. no*	*Pearson Correlation*
7	0.541**	1	0.492**	2	0.475**	5	0.574**
9	0.568**	3	0.472**	4	0.534**	8	0.549**
13	0.556**	6	0.425**	12	0.592**	18	0.553**
15	0.514**	10	0.567**	14	0.581**	24	0.507**
16	0.508**	11	0.499**	19	0.599**	29	0.612**
20	0.535**	17	0.448**				
25	0.482**	21	0.582**	23	0.555**	30	0.624**
26	0.536**	22	0.475**				
27	0.495**	28	0.506**				

**. Correlation is significant at the 0.01

Table (5) indicates that all correlation coefficient values were positive and statistically significant (0.01). Additionally, the correlation values of the individual score with the total score of dimensions ranged from 0.425 to 0.624, indicating a positive and significant correlation between the individual score and the total score to which it is assigned.

Degree correlation between each dimension and the total test score.

The degree correlation coefficient for each dimension was calculated with the total test score and the results are shown in the table below (6):

Table (6): Matrix of correlation between test dimensions and total score

Achievement test dimensions	Pearson Correlation
Knowledge	0.932**
Understanding	0.892**
Applying	0.867**
Higher Levels	0.886**

Table (6) above presented the degree of correlation between each achievement test dimension and the total test score. It can be seen from the table that all the values of the correlation coefficient are positive and operate at the (0.01) level, the dimensional correlation values with the overall test scores range from (0.867)) to (0.932), indicating a strong and almost complete correlation between item scores and overall test scores.

Test Reliability

1.Cronbach`s Alpha Coefficient

The Cronbach Alpha formula was used by the researcher to establish test reliability. The result is presented in the following table:

Table (7): Cronbach's Alpha of test dimensions and total score

Achievement test dimensions	N of Items	Cronbach's Alpha
Knowledge	9	0.833
Understanding	9	0.793
Applying	6	0.753
Higher Levels	6	0.784
All Test	30	0.877

It is clear from the results of table (7) that the reliability values for the dimensions ranged between (0.753, 0.833), and the reliability value for the test as a whole reached (0.877), which are high and statistically acceptable.

2. Split-Half:

The researcher used Spearman-Brown`s Split-Half to determine the reliability of the instrument. This was done by calculating the correlation coefficient between the ranks of the even questions and the ranks of the individual questions for the achievement test, it was found that the correlation coefficient was (0.856), and by substituting in the Spearman-Brown prediction equation, it was found that the reliability coefficient for the test as a whole was approximately (0.923).

Estimating the Ease, difficulty and ability to distinguish the test items

The purpose of estimating the coefficient of ease and difficulty of the test items is to eliminate very easy words with an ease coefficient of 0.8 or higher and very difficult words with an ease coefficient of 0.2 or less.

Another purpose for estimating the discrimination coefficient for the test items is to identify the ability of each test items to distinguish between

high achievement and low achievement of the participants in the experimental group. According to Elbahi (1979), if an item has discrimination coefficient of less than 0.2, it is measured as unexceptional.

Table (8): The coefficients of ease, difficulty and ability to distinguish for the achievement test items

Question	Facility factor	Difficulty factor	Discrimination factor
1	0.45	0.55	0.5
2	0.48	0.52	0.5
3	0.59	0.41	0.49
4	0.43	0.57	0.5
5	0.45	0.55	0.5
6	0.59	0.41	0.49
7	0.52	0.48	0.5
8	0.43	0.57	0.5
9	0.54	0.46	0.5
10	0.48	0.52	0.5
11	0.38	0.62	0.48
12	0.48	0.52	0.5
13	0.59	0.41	0.49
14	0.49	0.51	0.5
15	0.48	0.52	0.5
16	0.48	0.52	0.5
17	0.54	0.46	0.5
18	0.55	0.45	0.5
19	0.45	0.55	0.5
20	0.45	0.55	0.5
21	0.59	0.41	0.49
22	0.43	0.57	0.5
23	0.45	0.55	0.5
24	0.43	0.57	0.5
25	0.52	0.48	0.5
26	0.38	0.62	0.48
27	0.52	0.48	0.5
28	0.48	0.52	0.5
29	0.54	0.46	0.5
30	0.43	0.57	0.5

The results in Table (8) clearly show that all the values of ease, difficulty and discrimination coefficient for all items of the achievement test are within the acceptable range statistically possible; The coefficient values easily range from (0.38) to (0.59), which are statistically acceptable values. The value of the difficulty coefficient ranges from (0.41) to (0.62), which are statistically acceptable values. The values of the discrimination coefficients also range from (0.48) to (0.5), which are statistically acceptable values.

It is clear from the above that the entire achievement test has a level of validity and reliability that allows the researcher to use it in the present study, including (30) items based on the results for validity and reliability.

Results and Discussion:
The study raised the first sub question:

Is there any statistically significant effect at ($\alpha \leq 0.05$) for either teaching method, mental capacity, and the dual interaction between them on achievement of Nigerian secondary stage students in Biology?

To answer the above question, the following hypothesis was formulated:

There is no statistically significant effect at the level ($\alpha \leq 0.05$) either teaching method or mental capacity, or the interaction between them on the achievement for the Nigerian secondary stage students in Biology.

In order to test the hypothesis, the means and standard deviation of the students obtained in the post test administration was used as presented in the table below:

Table (9): Means and standard deviations of the research groups in the post of achievement test

Achievement dimensions	Groups	Mental Capacity	N.of cases	Means	S.D
Knowledge	Experimental	High	18	21.50	5.565
		Low	17	21.35	6.264
		Total	35	21.43	5.827
	Control	High	17	8.82	5.353
		Low	18	9.83	4.091
		Total	35	9.34	4.703
	Total	High	35	15.34	8.384
		Low	35	15.43	7.808
		Total	70	15.39	8.042
Understanding	Experimental	High	18	19.17	6.913
		Low	17	20.82	6.748
		Total	35	19.97	6.784
	Control	High	17	10.59	4.638
		Low	18	11.50	4.274
		Total	35	11.06	4.412
	Total	High	35	15.00	7.276
		Low	35	16.03	7.274
		Total	70	15.51	7.241
Applying	Experimental	High	18	13.67	5.657
		Low	17	15.18	3.893
		Total	35	14.40	4.870
	Control	High	17	5.82	3.592
		Low	18	6.17	3.634
		Total	35	6.00	3.565
	Total	High	35	9.86	6.156
		Low	35	10.54	5.883
		Total	70	10.20	5.987

Achievement dimensions	Groups	Mental Capacity	N.of cases	Means	S.D
Higher Levels	**Experimental**	High	18	13.50	5.469
		Low	17	14.82	4.915
		Total	35	14.14	5.174
	Control	High	17	5.12	3.935
		Low	18	6.00	3.850
		Total	35	5.57	3.860
	Total	High	35	9.43	6.349
		Low	35	10.29	6.229
		Total	70	9.86	6.258
Total score of Test	**Experimental**	High	18	67.83	21.807
		Low	17	72.18	19.856
		Total	35	69.94	20.692
	Control	High	17	30.35	14.226
		Low	18	33.50	12.316
		Total	35	31.97	13.176
	Total	High	35	49.63	26.348
		Low	35	52.29	25.417
		Total	70	50.96	25.734

Table (9) presented the mean and standard deviation of the experimental and control groups achievement score in the post administration**.** It is obvious from the results that there are differences between the means and standard deviations between the study groups according to teaching methods and mental capacity in the achievement test (dimensions and total score).

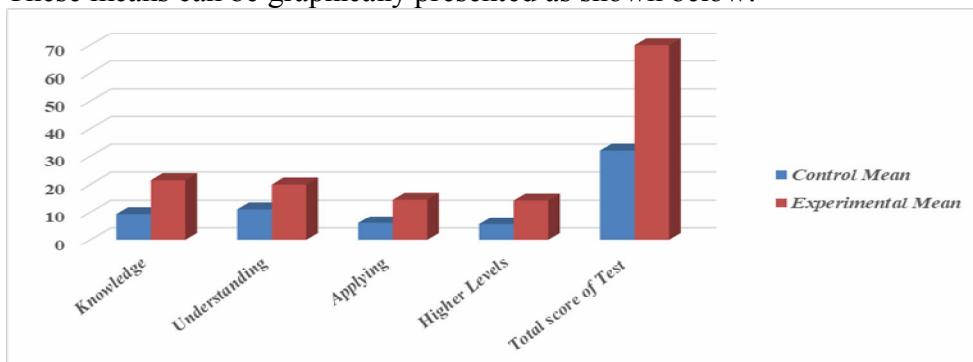These means can be graphically presented as shown below:

Figure (1): The means of two study group in dimensions and total score of achievement test

In order to determine the value of the differences and the level of their statistical significance on the achievement test (dimensions and total score), the researcher used the Two-way ANOVA. The following table shows the results:

Table (10): The results of Two-way ANOVA for the differences between the study groups in the post application of achievement test

Achievement dimensions	Variance resource	Sum of Squares	df	Mean Square	F	Sig.	η2
Knowledge	Teaching Method (A)	2559.254	1	2559.254	89.024	0.01	0.574
	Mental Capacity levels (B)	3.254	1	3.254	0.113	0.738	0.002
	Interaction (A×B)	5.850	1	5.850	0.204	0.653	0.003
	Inside groups (Error)	1897.353	66	28.748			
	Corrected Total	4462.586	69				
Understanding	Teaching Method (A)	1400.956	1	1400.956	42.113	0.01	0.390
	Mental Capacity levels (B)	28.842	1	28.842	0.867	0.355	0.013
	Interaction (A×B)	2.427	1	2.427	0.073	0.788	0.001
	Inside groups (Error)	2195.588	66	33.266			
	Corrected Total	3617.486	69				
Applying	Teaching Method (A)	1241.580	1	1241.580	67.309	0.01	0.505
	Mental Capacity levels (B)	15.009	1	15.009	0.814	0.370	0.012
	Interaction (A×B)	5.950	1	5.950	0.323	0.572	0.005
	Inside groups (Error)	1217.441	66	18.446			
	Corrected Total	2473.200	69				
Higher Levels	Teaching Method (A)	1294.128	1	1294.128	61.239	0.01	0.481
	Mental Capacity levels (B)	21.271	1	21.271	1.007	0.319	0.015
	Interaction	0.851	1	0.851	0.040	0.842	0.001

Achievement dimensions	Variance resource	Sum of Squares	df	Mean Square	F	Sig.	η2
	(A×B)						
	Inside groups (Error)	1394.735	66	21.132			
	Corrected Total	2702.571	69				
Total score of Test	Teaching Method (A)	25353.708	1	25353.708	82.801	0.01	0.556
	Mental Capacity levels (B)	245.250	1	245.250	0.801	0.374	0.012
	Interaction (A×B)	6.254	1	6.254	0.020	0.887	0.000
	Inside groups (Error)	20209.353	66	306.202			
	Corrected Total	45692.871	69				

Table (10) presented Two-way ANOVA results comparing the mean score of the experimental and control groups achievement test in the post-administration.

The following figures illustrate the results of the interaction between the teaching methods and mental capacity level of the achievement test dimensions and the total score:
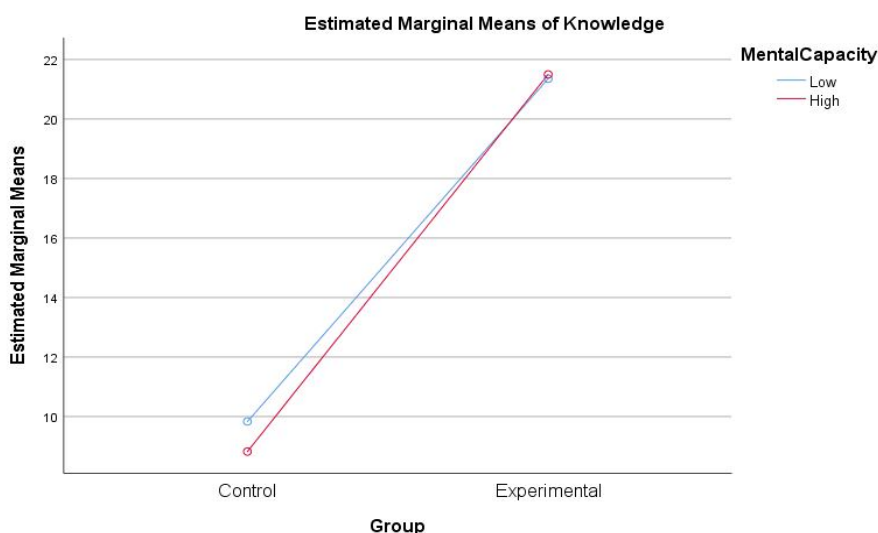
Figure (2): The interaction between the teaching method and the mental capacity level of Knowledge
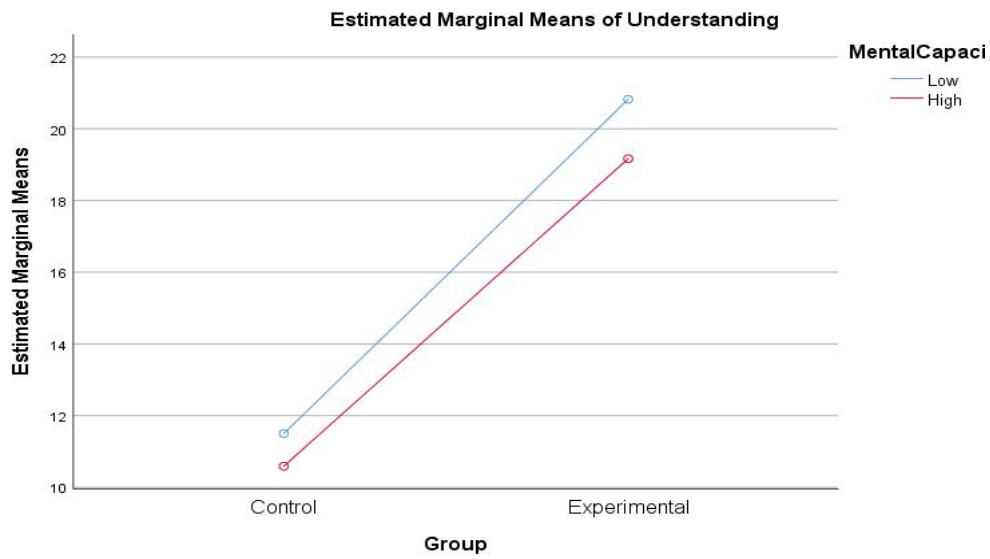
Figure (3): The interaction between the teaching method and the mental capacity level of Understanding
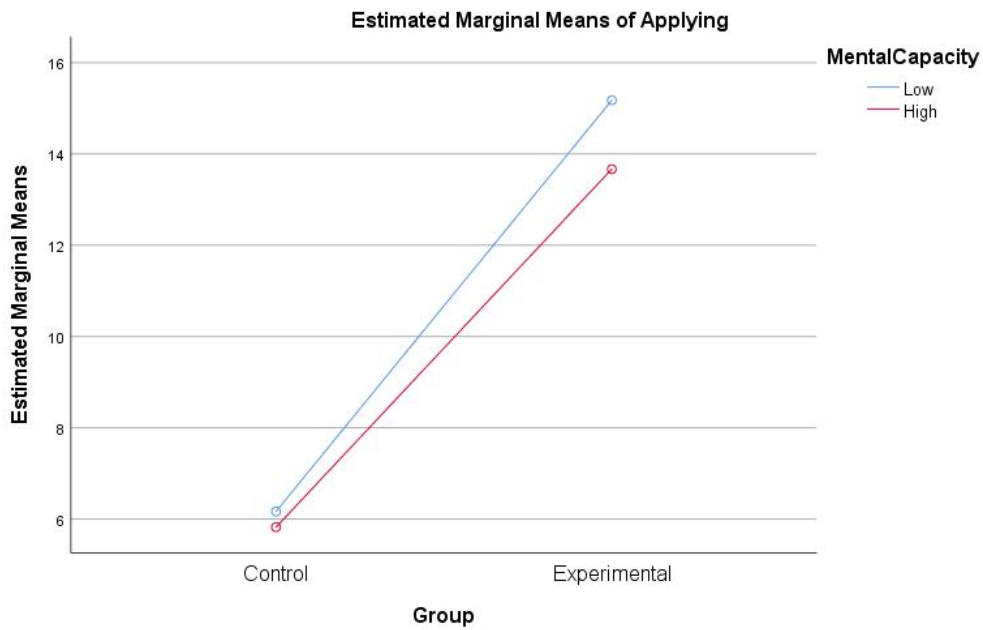

Figure (4): The interaction between the teaching method and the mental capacity level of Applying
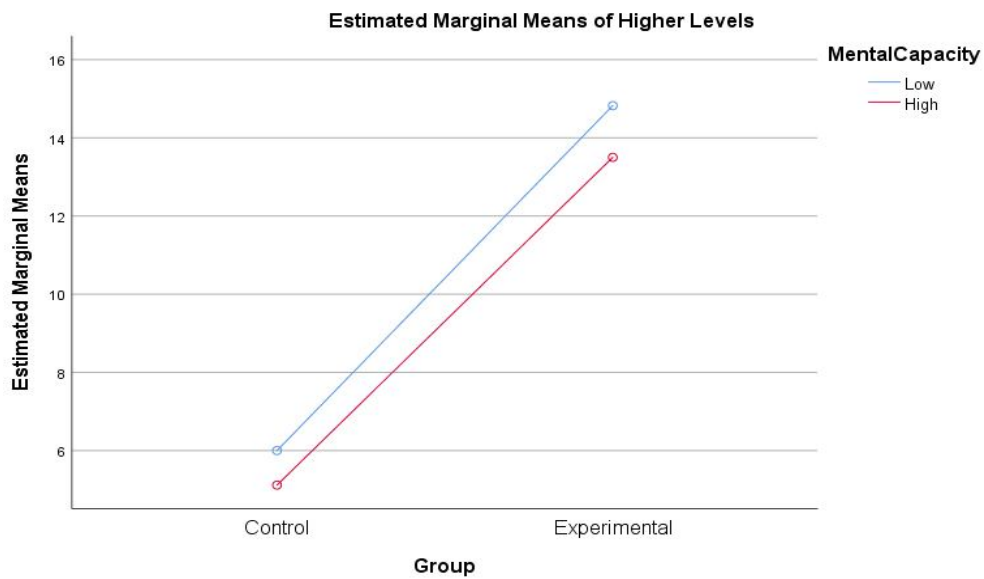
Figure (5): The interaction between the teaching method and the mental capacity level of Higher Levels
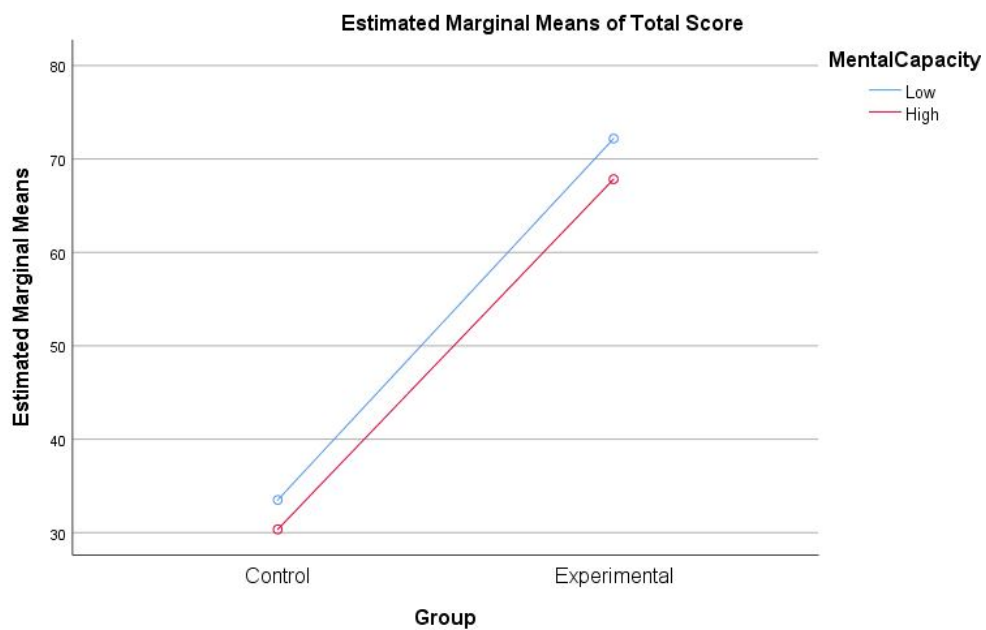

Figure (6): The interaction between the teaching method and the mental capacity level of total score of achievement test

Results in Table (10) and figures (2, 3, 4, 5 & 6) indicate that:

- There is a statistically significant effect at the level (a ≤ 0.05) between the study groups for the teaching method in the post achievement test (dimensions and total score) in favor of the experimental group.
- There is no statistically significant effect at the level (a ≤ 0.05) between the study groups for the mental capacity level in the post achievement test (dimensions and total score).
- There is no statistically significant effect at the level (a ≤ 0.05) between the study groups for the interaction between the teaching method and mental capacity level in the post achievement test (dimensions and totals score).

Additionally, it is noticed from Table (10) that the effect of experimental treatment on all achievement dimensions and the total score is high.

The effect size values of η^2 for the experimental treatment which the researcher used in the dimensions of the science process skills test ranged between (0.390) and (0.574), and the effect size value for the total score of the science process skills test was (0.556), which are all values indicative of a high effect size.

It is also obvious that the effect of mental capacity on all achievement dimensions and the total score is low, as all values of η^2 are less than 0.6.

Moreover, the size of the effect of the interaction between the teaching method and mental capacity on all achievement dimensions and the total score is low, as all values of η^2 are less than 0.6.

In order to indicate the direction of the statistically significant differences among the study groups, the researcher used the Tukey test for multiple comparisons for the achievement (dimensions and the total score). Results of the multiple comparisons are shown in the following table:

Table (11): Multiple comparisons between the means of study groups in the achievement dimensions and total score

Achievement dimensions	Groups	High Exp	Low Exp	High Ctrl	Low Ctrl
Knowledge	M	21.50	21.35	8.82	9.83
	High Exp	-	0.147	12.676*	11.667*
	Low Exp	-	-	12.529*	11.520*
	High Ctrl	-	-	-	1.010
Understanding	M	19.17	20.82	10.59	11.50
	High Exp	-	1.657	8.578*	7.667*
	Low Exp	-	-	10.235*	9.324*
	High Ctrl	-	-	-	0.912
Applying	M	13.67	15.18	5.82	6.17
	High Exp	-	1.510	7.843*	7.500*
	Low Exp	-	-	9.353*	9.010*
	High Ctrl	-	-	-	0.343
Higher Levels	M	13.50	14.82	5.12	6.00
	High Exp	-	1.324	8.382*	7.500*
	Low Exp	-	-	9.706*	8.824*
	High Ctrl	-	-	-	0.882
Total score of Test	M	67.83	72.18	30.35	33.50
	High Exp	-	4.343	37.480*	34.333*
	Low Exp	-	-	41.824*	38.676*
	High Ctrl	-	-	-	3.147

*. The mean difference is significant at the 0.05 level.

Table (11) above presented the multiple comparisons mean scores of the experimental and control groups in the achievement dimensions and total score in the post administration.

Findings from the Results

1. There is a statistically significant effect for teaching method at the level (a≤ 0.05) on the achievement for the Nigerian secondary stage students in Biology.

2. There is no statistically significant effect for mental capacity and the interaction between the teaching method and mental capacity at the level (a ≤ 0.05) on the achievement for the Nigerian secondary stage students in Biology.

The result shows that the experimental group who was taught the demonstration method outperformed the control group who was taught the conventional method in all the achievement test dimensions and totals scores.

The finding of this study is in line with the findings from previous researches on the effects of demonstration method on academic achievement. Such of these previous researches include the study conducted by Onyeka and Okoye (2023), Danjuma and Mankilik (2022), Loiser and Endne (2022), Omotayo and Taiwo (2021), Isaac, Bashir, Buba and Thlama (2020), Hussain (2020)

Conclusion

The study explores the interaction between teaching methods and students` mental capacity and its effect on Nigerian secondary stage students` achievement in Biology. The study found that demonstration method has significant effect on students' achievement in Biology. And there is no significant effect of the interaction between teaching method and mental capacity. Based on these findings, the study concluded that demonstration method significantly improved the secondary stage students' achievement in Biology.

Recommendation

The study recommends that demonstration teaching method should be incorporated into the secondary curriculum since it was found to enhanced students performance in Biology in order to promote active participation of students.

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