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**Research Article**

# Effect of Four Mode Application Technique on Biology Students Retention of Biology Concepts in Secondary Schools in Delta State

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**Abstract:** The study examined the effect of four mode application technique on Biology students' retention of Biology concepts in secondary schools in Delta State. The population of the study consisted of all senior secondary school two (SS2) Biology students in Delta State, with a population of 31, 572. The sample size of the study was 225 Biology students. Six schools were randomly selected using withdrawal with replacement approach. The study adopted the pretest posttest delayed posttest quasi-experimental design. The instrument utilised for data collection was the Biology Achievement Test (BAT). The collected data was evaluated by employing mean, standard deviation, independent sample t-test and Analysis of Variance (ANOVA). The findings of the study are: there is a significant difference in the mean retention scores of Biology students taught with four-mode application technique and those taught with lecture method in favour of the 4MAT group; there is no significant difference in the mean retention of male and female students taught Biology with 4MAT application technique; there is no significant interaction effect of method and sex on students' retention in Biology. It was concluded that the four-mode application technique has a significant effect on students retention as it helps students to retain what is being taught/learned. The study recommends that Biology teachers should use the four-mode (4MAT) application technique to teach their students to help them retain Biology concepts taught and teachers should be trained on how to teach using the four-mode (4MAT) application technique.

**Keywords:** Four-Mode Application Technique, Retention, Biology, Biology Concepts, Gender.

## INTRODUCTION

Biology is a core subject that is offered by pure science secondary school students in Nigeria who want to study medicine, nursing, pharmacology and related courses. Biology is the science of life. Therefore, its importance cannot be overemphasized. In spite of the significance of Biology, there is low retention rate of Biology concepts by Biology students and this has become worrisome. The ability to remember and make use of past knowledge and experience is known as retention. Retention of learning is the process of storing new information in long-term memory in a format that facilitates easy retrieval. There is a lot of cross-over between the fields of memory and retention research, but what really separates the two is the requirement that students demonstrate contextual recall in response to a prompt in order for material to be considered kept. Morris (2000) stated that when a stimulating situation occurs, retained images are revived or reproduced to make memorization possible. Okoye (2012) defined retention as the process of maintaining the availability of new meanings or some part of them. He said that active participation during instruction increases learning and retention. This low retention ability of Biology students in concepts is attributed to the teaching method used by Biology teacher to teach the subject, which is the lecture method. The lecture method used by Biology teachers to teach their students does not bring about active involvement of the students as the students are passive in the class.

Studies by Kurumeh *et al.*, (2012) and Ajayi and Ogbeba (2017) showed low students retention rate in Nigerian secondary schools. This low retention rate has been attributed to the use of ineffective and inappropriate teaching methods by teachers, which is the lecture method. This lecture method does not help Biology students to retain what is being taught and practiced at a later time. It does not bring about transfer of learning. To solve this problem, there is need to actively engage Biology students in the teaching learning process to help them retain what is being taught using active learning strategies such as the four-mode.

The four-mode teaching technique is that which organizes instruction to take care of the different learning styles of students as well as their hemispheric preferences (McCarthy, 2006). The main purpose of developing the 4MAT is to employ a beneficial learning environment. This model is grounded on the premise that individuals perceive and process information in different ways. The 4MAT application technique was developed by McCarthy in 1972. The theories she used were the Kolb's experiential learning theory and the brain dominance theory.

**RQs**

i. What is the difference in the mean retention score of Biology students instructed taught with 4MAT and those instructed with lecture method?
ii. What is the difference in the mean retention score of male and female Biology students instructed with 4MAT?
iii. Is there any interaction effect of method and sex on Biology students' retention?

**Hypotheses**

i. There is no statistically significant difference in the mean retention score of Biology students instructed with 4MAT and those taught with lecture method.
ii. There is no statistically significant difference in the mean retention score of male and female Biology students instructed with 4MAT.
iii. There is no statistically significant interaction effect of methods and sex on Biology students retention.

## METHODOLOGY

This study adopted the pre-test and posttest delayed posttest quasi-experimental design. Quasi-experimental design was utilised for this study because intact classes were used. The independent variable for the study was the four-mode application technique. The dependent variable was retention while gender was used as a moderator variable in the study. The study population comprised of all senior secondary school two (SS II) Biology students. The population comprised of 31,512. Six schools were randomly selected using withdrawal with replacement approach. This produced a sample of 225 Senior Secondary School II Biology students. The Biology Achievement Test (BAT) was utilised for data gathering/collection. The BAT consisted of 40 multiple choice items. The instrument served as a pretest, posttest, and a delayed posttest. Statistical mean was used to provide answer to research questions. Hypothesis 1 and 2 were tested using independent sample t-test while hypothesis 3 was analysed with Analysis of Variance (ANOVA) at 0.05 level of significance.

## RESULT

**RQ 1:** What is the difference in the mean retention score of Biology students instructed with 4MAT and those instructed with lecture method?

**Table 1:** Descriptive Statistics of Mean Comparing the Mean Retention of Biology Students instructed with 4MAT and those instructed with Lecture Method

| Groups | N | $\bar{X}$ | $\bar{X}$ diff | SD |
|---|---|---|---|---|
| 4MAT | 112 | 47.05 | 25.99 | 14.26 |
| Lecture | 113 | 21.06 | | 2.50 |

Table 1 above shows the descriptive statistics of mean showing the difference in mean retention scores of biology students instructed with 4MAT and those instructed with lecture method. From the table, 4MAT group had a higher mean retention of 47.05 with a standard deviation of 14.26 and the lecture method group had a lower mean retention of 21.06 with a standard deviation 2.50. This indicates that there is a difference in the mean retention of Biology students instructed with 4MAT and those with lecture method.

**Hypothesis 1**: There is no significant difference in the mean retention of Biology students instructed with 4MAT and those instructed with lecture method.

**Table 2:** Independent Sample t-test Comparing Retention Score of Biology Students instructed with 4MAT and those instructed with Lecture Method

| Group | N | $\bar{X}$ | $\bar{X}$ diff | SD | Df | t-cal | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|---|---|---|
| 4MAT | 112 | 47.05 | 25.99 | 14.26 | 223 | 17.26 | .000 | $H_{04}$ Rejected |
| Lecture | 113 | 21.06 | | 2.50 | | | | |

**P<0.05**

Table 2 shows the result of independent sample t-test indicating the difference in retention of Biology students instructed with 4MAT and those instructed with lecture method. The result showed that the calculated sig. value of 0.000 is less than 0.05 alpha level of significance (P<0.05). This indicates that there is a significant difference in the retention of Biology students instructed with 4MAT and those instructed with lecture method. Therefore, hypothesis 1 which states that there is no significant difference in the retention of Biology students instructed with 4MAT and those instructed with lecture method is rejected. Hence there is a significant difference in the retention of

biology students instructed with 4MAT and those instructed with lecture method in favour of the 4MAT group.

**RQ2:** What is the difference in the mean retention of male and female Biology students instructed with 4MAT?

**Table 3:** Descriptive Statistics of Mean and Standard Deviation Comparing the Retention of Male and Female Biology Students Instructed with 4MAT

| Groups | N | $\bar{X}$ | $\bar{X}$ diff | SD |
|---|---|---|---|---|
| Male | 52 | 47.12 | 0.12 | 15.03 |
| Female | 60 | 47.00 | | 13.68 |

Table 3 showed the retention of male and female Biology students instructed with 4MAT. The result from the table showed that male Biology students had a mean retention of 47.12 with a standard deviation of 15.03 while the female Biology students had a mean retention of 47.00 with a standard deviation of 13.68. This indicates that there is a difference in the mean retention of male and female Biology students instructed with 4MAT in favour of male Biology students. To determine if the difference is significant, independent sample t-test was used to test $H_{02}$ and the result is shown in table 4.

**H0$_2$:** There is no significant difference in the mean retention of male and female Biology students instructed with 4MAT.

**Table 4:** Independent Sample T-Test Showing the Mean Retention of Male and Female Biology Students Instructed with 4MAT

| Group | N | $\bar{X}$ | $\bar{X}$ diff | SD | df | t-cal | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|---|---|---|
| Male | 52 | 47.12 | 0.12 | 15.03 | 110 | .043 | .966 | **$H_{08}$ not Rejected** |
| Female | 60 | 47.00 | | 13.68 | | | | |

**P<0.05**

Table 4 presents the results of independent sample t-test which compared the difference in the mean retention of male and female Biology students instructed with 4MAT. The result demonstrates that the calculated sig. value of 0.966 is greater than the alpha level of 0.05 significance (p>0.05). This indicates that there is no statistically significant difference in the mean retention of male and female Biology students instructed with 4MAT. Therefore, the null $H_{02}$ is not rejected.

**RQ3:** Is there any interaction effect of methods and sex on Biology students' retention?

**Table 5:** Descriptive Statistics of Mean and Standard Deviation Showing the Interaction Effect of Methods and Sex on Biology Students' Retention

| Groups | Sex | N | $\bar{X}$ | SD |
|---|---|---|---|---|
| 4MAT | Male | 52 | 47.12 | 15.03 |
| | Female | 60 | 47.00 | 13.68 |
| | | 112 | | |
| Lecture | Male | 58 | 21.98 | 6.69 |
| | Female | 55 | 20.09 | 6.19 |
| | | 113 | | |

Table 5 presents the descriptive statistics of mean comparing the interaction effect of methods and sex on biology students' retention. The result from the table shows that the male Biology students instructed with 4MAT had a higher retention of 47.12 while the female Biology students instructed with 4MAT had a retention of 47.00 with a standard deviation of 13.68. The male Biology students instructed with lecture method had a retention of 21.98, while the female Biology students instructed with lecture method had a mean retention of 20.09. The male students from both groups had the highest mean scores when compared to their female counterpart. This shows that there is an interaction effect. To determine if the interaction is significant, ANOVA statistics was used to test $H_{03}$ and the result is shown in table 6.

**Ho$_3$:** There is no statistically significant interaction effect of methods and sex on Biology students' retention.

**Table 6:** Analysis of Variance (ANOVA) Summary of Interaction Effect of methods and sex on Biology Students' Retention

| Source | Type III Sum of Square | df | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Corrected Model | 38101.164* | 3 | 12700.388 | 103.203 | .000 |
| Intercept | 260057.393 | 1 | 260057.393 | 2113.212 | .000 |
| Methods | 37974.148 | 1 | 37974.148 | 308.576 | .000 |
| Sex | 56.491 | 1 | 56.491 | .459 | .499 |
| Methods * Sex | 44.248 | 1 | 44.248 | .360 | .549 |
| Error | 27196.836 | 221 | 123.063 | | |
| Total | 325398.000 | 225 | | | |
| Corrected Total | 65298.000 | 224 | | | |

***a. R Squared =.583 (Adjusted R Squared = .578)***

Table 6 shows the result of Analysis of Variance conducted to show the interaction effect of methods and sex on Biology students' retention. The table indicates that the calculated sig. value of 0.549 is greater that the critical sig. value of 0.05 ($p > 0.05$). This indicates that the interaction effect is not significant. Therefore, $H_{03}$ which states that there is no statistically significant interaction effect of methods and sex on Biology students' retention is not rejected.

## Discussion of Result

Result from hypothesis 1 on table 4 showed that there is a significant difference in the retention of Biology students instructed with 4MAT and those instructed with lecture method. The students in the 4MAT group have significantly higher mean retention than students in the lecture method group. This finding concur with the studies carried out by researchers like Khumwong and Singmuang (2013), Silver *et al.*, (2011), Dounghathai (2001), Lee and Hang (2009), Piyalux (2004), Pratoomtong (2011) and Nilita (2002) who found out that instructions based on 4MAT significantly improved students' retention.

Result from hypothesis 2 on Table 5 revealed that there is no statistically significant difference in the retention of male and female Biology students instructed with 4MAT. This indicates that male and female Biology students instructed with 4MAT retained equally. This finding agreed with that of Arighabu and Mji (2004), Bilesanmi-Awoderu (2006), Freeman (2002), Nwagbo and Obiekwe (2010), Lawal (2009) and Olasehinde and Olatoye (2014) who stated that there was no significant difference in the retention of male and female students in science.

Results from hypothesis 3 on table 6 showed that there is no significant interaction effect of methods and sex on Biology students retention. This indicates that the combined effects of method and sex did not influence Biology students' retention scores. In other words, method and sex acted independently in affecting Biology students' retention scores. This finding agreed with those of Ajaja (2013), Adeyemi (2012), Ezedinma and Nwosu (2018) and Okotcha (2018) who in their different studies discovered a no significant interaction effect between method and sex on students' retention.

## Conclusion

- Four-mode application techniques (4MAT) significantly influenced the retention of Biology students. This implies that 4MAT is enhances students retention than the lecture method
- Sex did not have significant effect on Biology students' retention. This indicates that the ability of a student to retain what is being learned does not depend on whether he or she is a male or female
- No interaction between sex of students and teaching method to influence Biology students' retention scores.

**Recommendations**

1. Biology teachers should use the four-mode application technique (4MAT) to teach their students to help them retain what is being taught since the 4MAT application technique significantly influenced Biology students retention in the study
2. Teachers/educators should be trained on how to teach using the four-mode application techniques. This will help them teach efficiently and effectively and improve students retention of concepts taught.

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