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THE UPSHOT OF MNEMONICS ON GENDER AND OTHER LEARNING OUTCOMES OF SENIOR SECONDARY SCHOOL STUDENTS IN BIOLOGY

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ABSTRACT: *This study investigated the effects of Mnemonics Instructional Strategy on Secondary School Students' learning outcomes in Biology. Moderating effects of Gender was also examined. The study adopted the pretest-posttest control group, quasi experimental design with 2x2 factorial matrixes. One hundred and twenty students from six public Schools selected from three Senatorial Districts in Ekiti State, Nigeria, participated in the study. Two instruments were developed and used: 'Students' Biology Achievement Test' (SBAT) and 'Students' Interest and Attitude towards Biology' (SIAB). The face and content validity of instruments was ensured by professional Biology teachers and experts in the field of Science Education. Reliability was done using test-retest method and adjudged to be reliable with results on Students' Biology Achievement Test (r=0.82) and Students' Interest and Attitude towards Biology (r=0.78). Also used were operational guides on Mnemonic Instructional Strategy, and Conventional Teaching Method. Three Null hypotheses were tested at 0.05 level of significant. Data collected was analyzed using Analysis of Covariance. The study revealed a significant effect of treatment on students' performance in, interest and attitude towards Biology, Gender have no significant effect on students' performance, interest and attitude towards Biology. The study recommends that, teachers should employ Mnemonics Strategy to create a Students'-centered teaching and learning, which will enhance Students' interest and attitude towards Biology, hence bring about an improved performance of Students in Biology.*

KEY WORDS: Biology, gender, learning outcome, mnemonics, students

INTRODUCTION

The need to study Science cannot be overemphasized in our Society. Virtually every day-to-day activity involves the application of Science. A Society devoured of Scientists is not likely to develop. The conventional teaching method alone may be unable to meet the societal expectations from the Science Classroom hence the introduction and incorporation of new instructional Strategies into the teaching of Science. Researches on the suggested best practices in teaching and learning of Science of which Biology is one, indicates that intrinsically, best practices in teaching and learning should aim at making learning interesting to learners thus aiding assimilation and recall of learnt concept (Akinsola and Odeyemi, 2014; Erinosho, 2008; McAlum and Seay, 2010). Undoubtedly, various innovative methods of teaching have been suggested of which are felt to

be capable of enhancing meaningful learning, such include concept mapping, peer tutoring, guided discovery and use of mnemonics (Achimugu, 2011; Ciccarelli and White, 2012; McAlum and Seay, 2010)

Biology is a popular Secondary School Science Subject of much importance to human well-being and development. Despite its importance, it is observed that Students portray misconceptions of the Subject; it is often perceived as being too wide, having many processes and full of elaborate scientific names which must be mastered during learning, hence not easily comprehended by Students. These can affect the interest, attitude and performance of Biology Students. Many at times, the teacher may be unable to impart learning and finish the syllabus in stipulated time, among the factors responsible for this are the approaches used by Biology teachers to disseminate knowledge which tend to portray Biology concepts in abstract and uninteresting to students. Thus, most often, students tend to view concepts in Biology as being too voluminous as they often are unable to remember them. The teaching and learning of science, especially Biology, is becoming more challenging due to richer and more rigorous content demands (Tanner and Allen, 2004; Adepoju, 2014). Biology Subject being a life study requires frequent recall of learned information for daily application, thus the need to commit to memory.

Various methods have been introduced to improve individual's ability to remember and store information for as long as possible, these includes; methods that improve attention, increase meaningful learning, use external memory, activate practice and repetition. Mnemonics Strategy is believed to be useful in achieving many of these. Mnemonics is derived from the Latin word *Mnemosyne* (Adina and Linnea, 2010). The word "Mnemonic" means "to remember" or "memory enhancing". The Greeks believes memory is a vital need in every facet of live. Thus a variety of memory techniques are designed by them to help remember information. Mnemonic strategy refer to use of memory driving techniques to remember facts by associating them with simpler forms of information and data. Mnemonic is defined as a memory aid meant to assist in the learning and recall of information that might have been somewhat problematic to recall (Mayson and Mohammed, 2017; Akinsola and Odeyemi, 2015) Memory is an amazing human advantage over other living things which enable humans to recall what happened to them long time ago. Memory is a biological process, which involves coded information, stored and recalled (Megan, Lawrence, Amy and Wendy, 2017).

Thus, Mnemonics Strategy should be understood as systematic procedure for intensifying memory. The main idea of mnemonic strategies as recorded by McCabe, Osha, Roche and Susser, (2013) is to develop better ways to encode (take in) information, so that it will be much easier to remember and retrieve. Thus, Mnemonic can be referred to as a learning Strategy which can often enhance the learning and later recall of information (Comber and Reeves, 1973 in Achimugu, 2011).

Mnemonics has proved to be an effective technique in enhancing individual memory capabilities, making the process of remembering something easier by connecting the information to be remembered with information that is easy to remember. Kleinheksel and Sumy, (2003) believed it connects and memorizes facts for easier access to the information and data available. Weng, Chang and Shyu, (2015) agreed that Mnemonics actively uses information in a form that is easy to remember in helping someone to remember what is important. Mnemonics can help Students from all levels; pre-School, Primary, Secondary, and Tertiary Education. It is evidenced from Education, that pupils and Student who are using Mnemonics strategy also perform better on

comprehension tests (Mastropieri, and Scruggs,1998; Mayson and Mohammed, 2017) Moreover, the use of Mnemonic devices operates by the use of cognitive structures and often results in very high levels of recall performance. The technique, on the other hand is characterized by low or no relation to the conceptual content of the material being learned but are focused only on certain aspects of their operation. The main task in developing mnemonic strategies is to find ways to connect new information to the information that is already stored in long-term memory. If learners make enough strong connection, the memory will last for a very long time, because the Mnemonic Strategy had carefully linked it to familiar things (Bellezza, 1996). Furthermore, a Mnemonic Strategy can be incorporated for the elements that require recall, these are useful ways of improving memory in Students, who exhibit difficulty with remembering things, Though Mnemonic strategy do not represent an Educational Panacea, but can be an important component in improving memory in learning and teaching process (Khoirunnisa, Annisa Siti, 2015; Latifah, Siti, Nurul, Aini, 2015; Lee and Nurul, 2019). Mnemonics Strategy could be very interesting tools for Biology teaching and learning due to the ongoing Research into alternative conceptions in Biology. It is opined that learning and remembering of information becomes better when presented in forms that are personal, surprising or humorous Awake! February (2009). Also when various scientific facts and procedures to be learnt are well connected to more familiar words and phrases (Achimugu, 2016; McAlum and Seay, 2010). A Biology Teacher while using Mnemonic Strategy devise high structured steps for learning efficiency. Among these structured steps are frequency, replication, rehearsal, and monitoring. This is believed by Latifah, et. al. (2015) to have value in the learning routines of Students with learning disabilities by directly translating to increased language growth. There are various Mnemonics Strategies that are used to maintain and recall information in the long-term memory. Interesting example of application of the Mnemonic strategies in Biology learning and teaching can include "Acronym" which is based on abstract word encoding the method. This is used by taking the initial letters of the names or content required to be learned and use inferences to symbolize a word or more to serve as a shortcut to those names or contents for example, the acronym "MR NIGERMAS C" representing the ten characteristics of living things: Movement, Respiration, Nutrition, Irritability, Growth, Excretion, Reproduction, Mortality, Adaptation, Size, Competition Another example of Mnemonics Strategy in Biology learning can be a "concrete word" encoding method of which Tanner and Allen (2004) applied to remember terms connected with the nervous system.

Researchers like Mayson and Mohammed (2017); Shawn, Thomas and Coleman (2003); Adepoju, (2014) Qais and Mohammed, (2014) & Ciccarelli and White, (2012) have identified various forms of Mnemonics; there is the "Keyword Strategy of Mnemonics" used to memorize foreign vocabulary by linking the foreign word with a word from the mother tongue which is totally or partially similar. The "Location Strategy" based on the idea of remembering a familiar set of places and linking them to the content to be remembered, the mental travel of those places will help in remembering the associated academic content. The "Peg Word Strategy" which is mainly used to remember lists, is based on linking words that have the same rhythm or sound, then creating mental links of these relations, the "Code or Rhyme Strategy'' concentrates on using the words to be remembered in a poem and links them to other words by rhyming, and the "Story Strategy" depends on connecting the things to be remembered with an innovative story. Yet, the "Met Memory Strategy" is related to thinking about the cognitive processes performed by observing, controlling, and directing them. The "Ridiculous Association Strategy helps link the content to be remembered for a cynical or ridiculous story or incident, the "Visualization Strategy" works through imaginative images, which means that the learner

conjures up an imagined picture of the experiences to be learned. And, the ”Embedded Picture-Letter Strategy” based on drawing the letters in the form of things whose name begins with the same sound and form of the letter.

Effects of Mnemonics on Gender is inconclusive, while some researches like Akinsola and Odeyemi (2015) in their study on effects of Mnemonic and prior knowledge instructional Strategies on Students' achievement in mathematics favoured male students over the females in performance, others researchers like Hung-Jeng, Dian-Fu and Hun-Yih (2015) recorded a non-significant gender effect on the use of Mnemonics among school pupils.

Considering the fact that one of the main problems encountered by Students in learning Science is that of inability to organize taught concepts in such a way as to facilitate ease of recall, it is thus felt that one vital means of enhancing learning of Science is through a Strategy that would aid students' memory. This is where Mnemonics comes in as a "best practice"; and innovative pedagogical approach to creative teaching and learning of Science. In general consideration, the Mnemonic devices are not teaching methods. It has also been proved by Scruggs and Mastropieri (2000) that Mnemonic Strategies can be used to enhance Science learning when the Curriculum involves a lecture-textbook format or when the curriculum involves a hands-on, inquiry learning format. However, in spite of many advantages it is possible to obtain a wrong conclusion that Mnemonic devices inhibit thorough understanding (Kilpatrick, 1985) contrarily, Mnemonic techniques are very good ways to understanding Science in School which in academic content be an important instructional component (Scruggs and Mastropieri 2000). It was observed also that, when Students generate their own Strategies, instruction may proceed at a much slower rate and Students' performances may be lower than when Teachers supply the Strategies (Scruggs and Mastropieri 2005). On the other hand, some studies indicated that Students who have been taught Strategies for creating their own Mnemonics outperformed compared to Students in free-study conditions. It can thus be summarized that, everyone needs individual developed Strategy, but it seems that combination of Student-generated and Teacher created Mnemonic Strategies is the best way.

Problem of the Study

It has been observed that Students' enrolment and performance in Biology is not encouraging. Students are being noticed to exhibit a decline in interest and attitude towards the learning of Biology and this has affected their performance and enrolment in external examinations and admissions into Tertiary Institutions to study life Science courses, which are vital to the development of the Society. The efforts of Education stakeholders to meet the Societal need of producing and training Scientist calls for innovative instructional Strategies to stir up and develop Students interest in Science learning of which Biology is one.

Purpose of the Study

The purpose of the study was to investigate the use of Mnemonics Strategy with reference to Gender in the teaching and learning of Secondary School Biology, It also investigated the use and effects of Mnemonics Strategy on the performance, interest and attitude of Secondary School Students in Biology.

Research Hypotheses

The following hypotheses were formulated and tested in the study:

1. There is no significant Gender difference in the performance of Biology Students exposed to Mnemonics learning Strategy and those not.
2. There is no significant Gender difference in the interest of Biology Students exposed to Mnemonic learning Strategy and those not.
3. There is no significant Gender difference in the attitude of Biology Students exposed to Mnemonics and those not

METHODOLOGY

The study is a quasi-experimental research of the Pre-test Post-test Control Group design. The population includes all the Biology Students in public Senior Secondary Schools in Ekiti State, Nigeria. Intact classes were involved. The sample was made up of 120 Biology Students drawn from six public Secondary Schools from the three Senatorial Districts of Ekiti State through a multistage sampling procedure. The independent variables are the teaching Strategy at two levels, (use of Mnemonics Strategy and Conventional teaching method) and Gender at two levels (male and female). A Biology science content Pre-test was used as a covariate. The design is structurally shown as follows:

Experimental Group: O_1 X_1 O_2
Control Group: O_1 X_2 O_2
Where O_1 = Pre-test assessment for experimental and Control groups (covariate)
X_1= Treatment, i.e. Mnemonics Strategy presentation
O_2 = Post-test assessment for experimental and Control groups
X_2 = Conventional teaching method

Two instruments were used to collect student data:

1. **Students' Biology Achievement Test (SBAT**). This instrument was constructed based on the Biology syllabus for the Senior Secondary School year I (SS I). It consists of 40 multiple-choice items with four possible answers for each question (A-D). To ensure the validity of the test items, a table of specifications, which showed the various levels of learning against the topic 'Functioning Ecosystem' was prepared. Based on the learning objectives, test items were constructed. Validity of the instrument was carried out by Biology teachers and Science Educationists. The SBAT underwent trial tests on twenty SS I Students from two Schools not participating in the research, using test–retest method. From the Students' responses, a reliability coefficient of 0.82 was established using Pearson Product Moment Correlation analysis. This was adjudged high enough to be reliable. The ability levels of participants was determined by their scores in BSAT (high = 45% and above while low = 45 and below) and their continuous assessment (CA) scores in Biology was used to establish their ability levels. BSAT was used both as Pre-test and Post-test.

2. **Students' Interest and Attitude towards Biology (SIAB**). It is an instrument used to seek information on Biology students' general interest and attitude towards learning biology. It was made up of section (A) bio data and section (B) consisting of 40 items, 20 each, on attitude and interest, using a 4-point likert type of strongly agree(SA), agree (A), disagree (D) and strongly disagree(SD). Face and content validity of the

instrument was carried out by Biology teachers and Science Educationists. Using test-retest method, its reliability value was 0.78 when calculated using Pearson Product Moment Correlation analysis. Both the Experimental and Control groups were given the Pre-test SBAT at the same time to determine their entry behaviour and SIAB was also administered on both groups of students. Following the Pre-test, the two groups were exposed to their treatments – Mnemonics Strategy on the topic, 'Functioning Ecosystem' and Conventional instruction on 'Functioning Ecosystem'. After the treatment, the Post-tests SBAT and SIAB were administered on the two groups. Data collected were analyzed using descriptive Statistics of mean and standard deviation, and inferential Statistics of Analysis of Covariance (2x2 ANCOVA) to determine the effect of Mnemonics Strategy and Gender on Students' attitude, performance and interest in learning Biology. The study involved three stages;

Pre-treatment stage: The Researcher visited the Principals of Schools to be used for study to seek permission to use their Schools. When granted permission, the Researcher met with the Head of Science Department who linked her with the Biology teachers involved. The Researcher trained the Biology teachers to enable join in carrying out the experiment procedures. The instruments SBAT and SIAB were administered as both Pre-test and Post-test. As Pre-test, it was administered with the help of research assistants (Biology teachers) located in the Schools used for the study. Pre-test was used to determine the homogeneity of the sample as well measure the attitude of Students towards Biology before treatment. This was done in one week

Treatment stage: This involved the use of Mnemonic Strategy in teaching the Experimental group while the Conventional method only was used to teach the Control group. The treatment (Experimental and Control) lasted for four weeks of the secondary school biology study period.
Post-treatment stage: The SBAT and SIAB were administered on the subjects for the study as post-test. The results of the pre-test and post-test were recorded and used for analysis. This was done in one week.

RESULTS

For hypothesis 1, 2X2 ANCOVA was used to test the Gender and performance of Biology Students in using Mnemonics. The result is presented in table 1.

Table 1: 2 X 2 ANCOVA of Gender and treatment on the performance of Biology students

Source	SS	Df	MS	F	P
Corrected Model	9964.62	4	2491.15	664.16	.00
Covariate(Pretest)	9236.52	1	9236.52	2462.51	.00
Gender	1.09	1	1.09	.29	.59
Group	454.24	1	454.24	121.10	.00
Gender * Group	.00	1	.00	.00	.98
Error	431.35	115	3.75		
Corrected Total	10395.97	119			
Total	379804.00	120			

p>0.05

Table 1 shows that there is no significant Gender difference in the performance of Biology Students exposed to Mnemonics and those not ($F_{1, 115}$=0.00, p>0.05). The null hypothesis is not rejected. Also, the effect of Gender on the performance of Biology students is not statistically significant at 0.05 level ($F_{1, 115}$=0.29, p>0.05). However, treatment had significant main effect on the performance of Biology Students at 0.05 level ($F_{1, 115}$=121.10, p<0.05).

For hypothesis 2, 2X2 ANCOVA was used to test the difference in Gender and interest of Biology Students in using Mnemonics. The result is presented in table 2.

Table 2: 2 X 2 ANCOVA of Gender and treatment on the interest of Biology Students

Source	**SS**	**Df**	**MS**	**F**	**P**
Corrected Model	16063.22	4	4015.81	74.95	.00
Covariate (Pretest)	41.87	1	41.87	.78	.38
Gender	.06	1	.06	.00	.98
Group	14669.69	1	14669.69	273.81	.00
Gender * Group	8.56	1	8.56	.16	.69
Error	6161.37	115	53.58		
Corrected Total	22224.60	119			
Total	384455.00	120			

p>0.05

The result in Table 2 shows that there is no significant Gender difference in the interest of Biology Students exposed to Mnemonics strategy and those not ($F_{1,115}$=0.16, p>0.05). The null hypothesis is not rejected. Also, the effect of Gender on the interest of Biology Students is not statistically significant at 0.05 level ($F_{1,115}$=0.00, p>0.05). However, treatment had significant main effect on the interest of Biology Students at 0.05 level ($F_{1,115}$=273.81, p<0.05).

For hypothesis 3, 2X2 ANCOVA was used to test the difference in Gender and attitude of Biology Students tin using Mnemonics. The result is presented in table 3.

Table 3: 2 X 2 ANCOVA of gender and treatment on the attitude of biology students

Source	**SS**	**Df**	**MS**	**F**	**P**
Corrected Model	13468.01	4	3367.00	106.97	.00
Covariate (Pretest)	.83	1	.83	.03	.87
Gender	14.45	1	14.45	.46	.50
Group	12855.56	1	12855.56	408.41	.00
Gender * Group	9.72	1	9.72	.31	.58
Error	3619.91	115	31.47		
Corrected Total	17087.92	119			
Total	387051.00	120			

p>0.05

Table 3 shows that there is no significant Gender difference in the attitude of Biology Students exposed to Mnemonics and those not ($F_{1,115}$=0.31, p>0.05). The null hypothesis is not rejected. Also, the effect of Gender on the attitude of Biology Students towards learning is not statistically significant at 0.05 level ($F_{1,115}$=0.46, p>0.05). However, treatment had significant main effect on the attitude of Biology Students towards learning at 0.05 level ($F_{1,115}$=408.41, p<0.05).

DISCUSSIONS

The result of the study recorded a no significant Gender difference in the performance of Biology Students exposed to Mnemonics and those not, but a significant effect was recorded on Biology Students' performance in the Subject after treatment. This agrees with the submission of Kamil, Anna and Małgorzata (2015) in their preliminary studies about knowledge and applications of Science Mnemonics by Polish pupils, that the use of Mnemonic devices often results in very high levels of recall performance amongst males and females. The study also recorded a no significant Gender difference on the interest of Biology Students exposed to Mnemonics Strategy and those not, and a significant effect of treatment on Biology Students' interest in the Subject. There was a sort of stirring up in Students when Mnemonics Strategy was introduced, an unbiased Gender enthusiasm was observed in Biology Students as they each tried to create "Acronyms" and Concrete words encoding" in humorous ways. When discussing how students learn science John (2005) believes that the learning of science subjects should be made interesting to catch students' attention in class. A non-significant Gender difference and a positive effect of treatment were recorded in the attitude of Biology Students exposed to Mnemonics and those not. These results is in agreement with McAlum and Seay (2010) who stated that Mnemonics enhance recall of stored information by providing a scaffold that links what the Students are familiar with to that which they are to learn. This aids the Students in making mental snapshots of the information to be learned (McAlum and Seay 2010). Gender was discovered not significant in the ability of Mnemonics to enhance memory in effecting performance, interest and attitude in Biology Students. This was in line with Hung-Jeng, Dian-Fu and Hun-Yih (2015) who discovered a no significant Gender effect of Mnemonics among pupils. However, this is in contrast to the findings of Akinsola and Odeyemi (2015) in their study on effects of Mnemonic and prior knowledge instructional Strategies on Students' achievement in mathematics, where a better performance of male Students was recorded while using Mnemonics instructional Strategy.

The Study recommends based on its findings that:

- Teachers should employ and facilitate the use of Mnemonic instructional Strategies in Schools to enhance positive attitude in Students towards Biology and improve their interests and performance in the Subject.
- The use of Mnemonics Strategy should be employed and encouraged in teaching other Science subjects to promote retention in learners and help in remembering the knowledge gained especially during examinations
- Varieties of Mnemonics forms should be included in instructional Strategies to stir learners' interest in learning activities and to effectively cater for the learning needs of different ability levels of Students in their Classrooms.
- Periodic and regular Training, Seminars and Workshops should be organized for Secondary school teachers to update their knowledge on current and innovative teaching Strategies.

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