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Effect of Four–Mode Application Technique on Students' Interest in Secondary School Chemistry

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ABSTRACT

This study investigated the effect of Four – Mode Application Technique (4MAT) on interest of secondary school chemistry students. Three research questions guided the study and three null hypotheses formulated were tested at .05 significant level. Non-equivalent control group of Quasi-experimental design was adopted for the study. The study was carried out in Enugu education zone of Enugu state with a sample size of Two hundred and ninety-five (295) SSII chemistry students (132 boys and 163 girls). Organic Chemistry Interest Inventory (OCII) with reliability index of 0.86 was the instruments developed, validated and used for pre-test and post-test. The experimental group was exposed to 4MAT while control group was exposed to lecture method. All the research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses. The results of the study revealed that there was a significant difference in the mean interest scores of students taught organic chemistry using 4MAT, F (281.346), p<.000, and there was no significant interaction between gender and teaching strategies on students' mean interest scores in organic chemistry, F (22.058), p<.818. In line with the findings of the study, the educational implications of the findings were highlighted, and recommendations proffered among others that science teachers, science educators, authors and textbook writers should adopt 4MAT when teaching or writing of textbooks to enhance students' interest in chemistry.

Keywords: Four-Mode Application Technique (4MAT), Interest, Organic Chemistry

Introduction

Chemistry, with its different branches, which include analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry and biophysical chemistry; is an important science subject that stands as part of the foundation for specializing in such science-based professions like Medicine, Pharmacy, Nursing, Engineering, Biochemistry, Genetics and Agriculture; all of which are of great importance to the nation. For this reason, chemistry has a very high enrolment of students in the external examination (West African Examination Council, 2014).

The objectives of the chemistry curriculum according to the National Policy on Education are to prepare students to acquire: adequate laboratory and field skill in chemistry, meaningful and relevant knowledge of chemistry, the ability to apply scientific knowledge to everyday life and to acquire reasonable and functional scientific attitude (National Policy on Education, FRN, 2014).

To achieve the objectives of the chemistry curriculum, (Pratoomtong, 2011), emphasis should be placed on the teaching and learning process in order to allow students develop their highest potentials because chemistry education plays important roles in enhancing the quality of teaching and research as well as ensuring that students are equipped with good knowledge to produce intensive goods and services to meet human needs for food, healthcare products and other materials aimed at improving the quality of life.

Interest is often thought of as a process that contributes to learning (Hidi, 2018). Interest is a powerful motivational process that energizes learning, guides academic and career trajectories, and is essential to academic success. It is both a psychological state of attention and affection towards a particular object or topic, and an enduring predisposition to re-engage over time. When students are interested in any academic topic, they are more likely to go to class, pay attention, become engaged, take more courses, as well as process information effectively and ultimately perform well. Students who discover academic interest in high school and college are better prepared for satisfying careers (Renninger & Hidi, 2014). Interest can either be situational interest (extrinsic / externally induced) or individual interest (intrinsic / internally induced). Interest can be built when the students are engaged effectively in teaching and learning (Edglossary, 2016). A student's lack of interest in learning often stems from having no interest in the concepts or material presented to them. Sometimes the way the learning content is presented also turns students off and it is the duty of the teacher to engage the students with the best strategy that will not only arouse, but sustain their interest throughout the lesson period.

The use of suitable teaching strategy plays a very important role in classroom transaction. A teacher, who adopts proper teaching strategies, successfully motivates students to learn. One of the teaching strategies that have been designed in such a way that the learners can find ample period of time for themselves is Four Mode Application Technique (4MAT), which aims at presenting a teaching strategy which takes all the learning styles of the students into consideration. 4MAT system is a process for conveying instructions in a way that involves, informs, and permits practice and creative use of material learned within each class (Uyangor, 2012).

4MAT requires teachers to present learning materials appropriately so that learners can use their own learning styles well and become successful. The Universal Design of Learning (UDL, 2017), noted that 4MAT is a teaching strategy compatible with the brain. It provides a structure to respond to the needs of learners and to their preferences, by allowing them to transfer their knowledge via a quadrant cycle of Engage – Share – Practice – Perform phases.

- Engage – this entails engaging the learner by creating new experiences that captures the attention of the learner and generates intrigue; a type of curiosity regarding what will be taught. It answers the question "why" as the teacher acts as a facilitator. This first quadrant deals with the 1st and 2nd sub sections known as 'Connect' & 'Examine', dealing with "meaning" from learning.
- Share – this entails sharing knowledge, that is, the subject of application in the real world. It answers the question "what" as the teacher acts as a presenter. This second quadrant deals with the 3rd&4th sub sections known as 'Image' & 'Inform', dealing with "concepts" from learning.
- Practice – this involves moving to a particular phase by placing the learner in a situation of applying all of the shared information during the second phase of the cycle. It answers the question "how" as the teacher acts as a coach. This third quadrant deals with the 5th& 6th sub sections known as 'Practice' & 'Extend', dealing with "skills" to be learnt.
- Perform – this brings learners to think about barriers that could emerge and how to adapt and refine what they have learned so that they can put this knowledge to use in the real world. It answers the question "if" as the teacher acts as the evaluator. This fourth quadrant deals with the 7th& 8th sub sections known as 'Refine' & 'Perform', dealing with "adaptations" from learning.

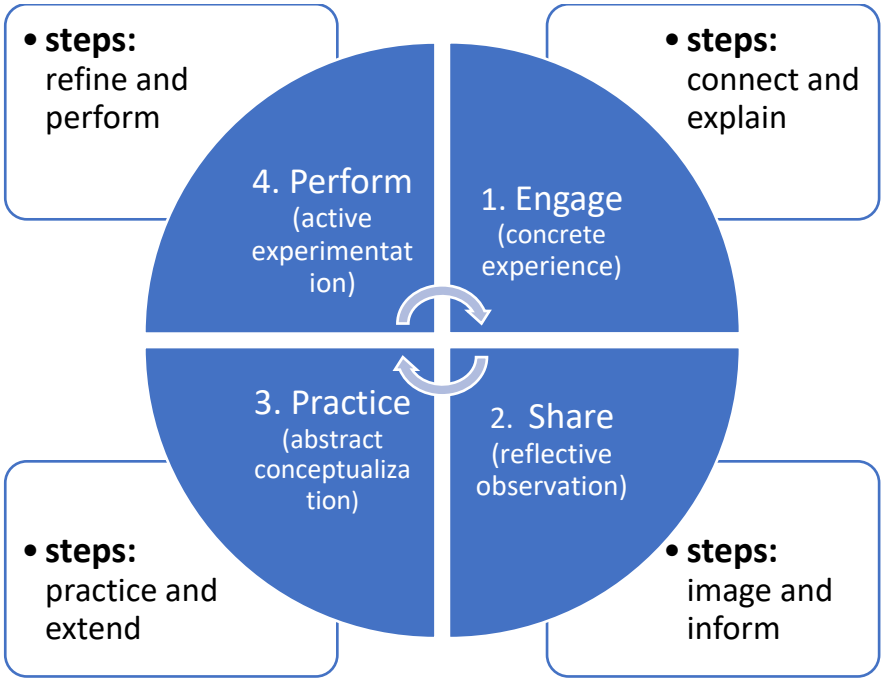

Fig. 1 – Kolb's Type Learner Cycle

For example, using 4MAT to teach the concept of 'matter' in chemistry, the teacher in the first phase, allows the students to go and work the various outlines contained in the topic (*engage*); groups them in the second phase, to discuss amongst themselves their individual findings (*share*); summarize their work as a group to accommodate all their contributions in the third phase (*practice*); and present it to the general class as their collective work (*perform*).

Another issue of contention in Nigeria today is the issue of gender in our society including the educational system. Gender is a set of characteristics distinguishing between male and female, particularly in the cases of men and women which depending on the context, may vary from sex, to social role, to gender identity (Bland, 2003). According to Okeke (2008) gender is a social or cultural construct, characteristics, behaviour and role that varies from place to place, or culture to culture. Gender related issues in science education have continued to receive serious attention, judging from the number of studies done to that effect. Babajide (2010) opined that science subjects, which include physics, biology and chemistry, are given masculine outlook by educational practitioners.

Some researchers like Eric (2015), found that male students perform better than females in chemistry. The students' lack of interest and poor achievement in chemistry could be attributed to so many factors such as poor classroom management, use of gender biased instructional material, lack of adequate instructional materials, lack of adequate laboratory activities,

ineffective teaching methods employed in teaching chemistry by the secondary school teachers, lack of appropriate instructional strategy and lack of competent chemistry teacher.

In this study, the 4MAT model was used to design learning activities in chemistry and determined its effect on interest of students in chemistry.

Purpose of the study

The main purpose of this study was to investigate the effect of Four Mode Application Technique (4MAT) on interest of students in Chemistry. Specifically, this study determined:

1. The mean interest scores of chemistry students taught Organic Chemistry using the Four Mode Application Techniques (4MAT) with those taught with lecture method;
2. The mean interest scores of male and female chemistry students taught organic chemistry using the Four Mode Application Techniques (4MAT);
3. The interaction effect of teaching strategies with gender on students' mean interest scores in organic chemistry.

Research Questions

The following research questions were posed to guide this study:

1. What is the mean interest score of SS2 chemistry students taught Organic Chemistry using the 4MAT?
2. What is the mean interest score of male and female SS2 chemistry students taught organic chemistry using the 4MAT?
3. What is the interaction effect of 4MAT with gender on students' mean interest scores in organic chemistry?

Hypotheses

The following hypotheses were formulated and tested at alpha level of 0.05.

Ho_1: There is no significant difference between the mean interest scores of SS2 chemistry students taught Organic Chemistry using the 4MAT with those taught with lecture method;

Ho_2: The mean interest scores of Chemistry students do not differ significantly based on gender when taught using 4MAT;

Ho_3: There is no significant interaction effect of teaching strategies with gender on students' mean interest scores in organic chemistry.

Methodology

Quasi-experimental design, specifically the non-equivalent control group design was employed in this study while the area of this study was Enugu Education zone of Enugu State. Two hundred and ninety-five (295) SSII chemistry students from four intact classes (two from each school, one served as treatment while the other served as control), formed the sample size of the study. This consists of 150 students for the treatment group and 145 students for the control group; and 132 boys and 163 girls. The instruments developed for data collection in this study was organic chemistry interest inventory (OCII) which was structured in four-point rating scale with the following four response options to which numerical value were assigned thus: strongly agree (SA) = 4, Agree (A) = 3 Disagree (D) = 2 and strongly disagree (SD) = 1; with an internal consistency reliability coefficient of 0.86 arrived at using Cronbach's alpha formula.

All the research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05% level of significance.

Results

The results were presented in accordance with the research questions and hypotheses that guided the study.

Responses on mean interest scores of students taught organic chemistry using 4MAT and those with lecture method

For this research question, data obtained with the OCII for the treatment and control groups were used to answer the research question. Mean for pre-test and post-test were adjusted statistically in the analysis to take care of the initial equivalence of the research subjects. Summary of result of data analysis is presented in table 1.

Table 1: *mean interest scores of students taught organic chemistry using 4MAT and those with lecture method*

Group	N	Adjusted Mean (x)	Standard Deviation (SD)
Treatment (4MAT)	150	79.95	6.95
Control (Lecture)	145	53.77	9.62

Result on Table 1 showed that those students taught organic chemistry using 4MAT had a higher mean interest score (79.95), having SD of 6.95, than those taught using lecture method (53.77), having SD of 9.62. This implies that 4MAT enhanced the students' academic interest in organic chemistry than the conventional lecture method.

Response on mean interest scores of male and female students taught organic chemistry using 4MAT

For this research question, data obtained with the OCII for the treatment group was used to answer the research question. Mean for pre-test and post-test were adjusted statistically in the analysis to take care of the initial equivalence of the research subjects. Summary of result of data analysis is presented in table 2.

Table 2: *summary of mean interest scores of male and female students taught organic chemistry using 4MAT*

Group	N	Adjusted Mean (x)	Standard Deviation (SD)
Male	66	84.92	4.49
Female	84	74.45	4.70

Result on Table 2 showed that male students taught organic chemistry using 4MAT had a higher mean interest score (84.92), having SD of 4.49, than their female counterparts (74.45), having SD of 4.70. This implies that 4MAT enhanced the male students' interest score in organic chemistry than that of their female counterparts.

Response on interaction between gender and teaching strategies on students mean interest scores in organic chemistry

Adjusted mean for the two levels of gender that were subjected to 4MAT and those subjected to the lecture strategy were used to access the interaction. Summary of result is presented in table 3.

Table 3: *summary of interaction between gender and teaching strategies on students mean interest scores in organic chemistry*

Gender group	Adjusted mean for 4MAT	Adjusted mean for Control

Male	84.92	63.00
Female	74.45	46.06

Summary of result presented in Table 3 reveal clearly that the mean interest scores of 4MAT (84.92 and 74.45) is higher than that of lecture method (63.00 and 46.06) at the two levels of gender (male and female respectively).This implies that 4MAT enhanced both the male and female students' interest scores in organic chemistry than that of their counterparts taught with lecture method.

Response on analysis of co-variance for students' overall organic chemistry interest scores by ***teaching methods*** *and by* ***gender***

Hypothesis 1: There is no significant difference between the mean interest scores of students taught Organic Chemistry using the Four Mode Application Techniques (4MAT) and their counterparts taught the same topic using lecture method.

Hypothesis 3: There is no significant interaction effect of teaching strategies with gender on students' mean interest scores in organic chemistry.

These two hypotheses were tested using ANCOVA. Summary of the analysis for the two null hypotheses is shown in Table 4.

Table 4: Analysis of co-variance for students' overall organic chemistry interest scores by teaching methods and by gender

Table 4: *Analysis of co-variance for students' overall organic chemistry interest scores by teaching methods and by gender*

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Significance**	**Decision**
CorrectedModel	66772.896[a]	4	16693.224	5344.311		
Intercept	445.405	1	445.405	142.596		
Pre-test	5258.285	1	5258.285	1683.432		
4MAT Method	**878.797**	**1**	**878.797**	**281.346**	**.000**	**S**
Gender	1079.218	1	1079.218	203.875	.000	S

4MAT*Gender	**68.901**	**1**	**68.901**	**22.058**	**.818**	**NS**
Error	905.830	290	3.124			
Total	1377368.000	295				
Corrected Total	67678.725	294				

For hypothesis 1, the ANCOVA table shows the sig. value of 0.000 is less than 0.05. The decision rule is to reject the null hypothesis when the sig. value is less than alpha value of 0.05. Since the sig. value is than 0.05, the null hypothesis was rejected. The study concludes that there is a significant difference between the mean interest scores of students taught organic chemistry using 4MAT and that of those taught organic chemistry using lecture strategy.

For hypothesis 3, result in Table 4 revealed that for two-way interaction, F.Sig. is 0.818 which is greater than 0.05. Based on the decision rule, the researcher did not reject the null hypothesis and concludes that there is no significant interaction between gender and teaching strategies on students' mean interest scores in organic chemistry.

Response on analysis of co-variance for male and female students' overall organic chemistry interest scores by gender

Hypothesis 2: The mean interest scores of Chemistry students do not differ significantly based on gender when using 4MAT.

Table 5: *Analysis of co-variance for male and female students' overall organic chemistry interest scores by gender*

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Significance**	**Decision**
Corrected Model	6965.617[a]	2	3482.808	2217.837		
Intercept	336.650	1	336.650	214.378		
PRETEST	2912.587	1	2912.587	1854.723		
GENDER	***793.634***	***1***	***793.634***	***505.382***	***.000***	**S**
Error	230.843	147	1.570			
Total	944769.000	150				

Corrected Total	7196.460	149				

Summary of result on Table 5 shows that the sig. value of 0.000 is less than 0.05. The decision rule is to reject the null hypothesis when the sig. value is less than alpha value of 0.05. Since the sig. value is less than 0.05, the null hypothesis was rejected. The researcher concludes that there is a significant difference between the mean interest scores of male and female students taught organic chemistry using 4MAT. This implies that 4MAT enhanced the interest of male students more than the female students in organic chemistry.

Summary of Findings

This study recorded the following findings:

1. Students taught organic chemistry using 4MAT had higher mean interest scores than those taught using the conventional lecture strategy. This is in line with the constructivist theory that admitted that effective learning occurs when learners are actively involve and construct their own knowledge. This advocates for hands-on and minds-on strategy which 4MAT provides while sustaining the interest of the learner. In 4MAT, all learners have equal chances of learning and constructing their knowledge unlike the lecture method.
2. There was a significant difference between the mean interest scores of male and female students taught organic chemistry using 4MAT in favour of the male students. This might be as a result of some research findings which showed that male perform better than their female counterparts in science due to the difference in their brain function as outlined in 4MAT.
3. There was no significant interaction between gender and teaching strategies on the mean interest scores of the students because both male and female students in the treatment (4MAT) group clearly had higher mean interest scores than those in the control group. This is as a result of the proven superiority of 4MAT when compared to lecture method.

Conclusion

From the results obtained in the study on the effects of Four Mode Application Technique (4MAT) on interest of students in organic chemistry, it was found that:

- Students taught organic chemistry using 4MAT had higher mean interest scores than their counterparts taught using the conventional lecture method because the difference in their mean interest scores was statistically significant.

- Gender significantly influenced students' mean interest scores in organic chemistry when taught using 4MAT, the posttest mean interest scores of male students were higher than those of their female counterparts.
- There was no significant interaction between gender and teaching strategies on the mean interest scores of the students in organic chemistry because both male and female students in the treatment (4MAT) group clearly had higher mean interest scores than those in the control group.

Recommendations

In line with the findings of this study, the following recommendations were made;

1. Teaching and learning through 4MAT was observed and it was found that most students were very interested in doing activities, enthusiastic about doing group activities, had fun, and were happy because they did experiments and activities by themselves as well as working in groups with friends. Therefore, teachers should apply these activities for other contents and levels.

2. Teachers should provide variety of activities and opportunities for students to use their skills continuously.

3. The results of this study show that students who were taught organic chemistry with 4MAT attained higher interest score than students who were taught using traditional lecture method. Hence, teachers should employ 4MAT in teaching in order to both arouse and sustain the interest of the students.

4. Students' gender should be taken into cognizance during teaching especially when teaching organic chemistry. The findings of this study revealed that gender was a significant factor in mean interest scores of students; hence, teachers should use instructional approaches that can streamline gender differences in science classrooms.

5. Science teachers should be trained on how to use 4MAT and other innovative student-centered instructional approaches in teaching. This can be done by organizing periodic workshops and seminars for teachers.

References

Bland, R. W. (2003). *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann.

Babajide, V. F. T. (2010). Generative and predictive-Observe-Explain

instructional strategies as determinants of senior secondary school students' achievement and practical skills in Physics. *Unpublished Ph.DThesis, University of Nigeria, Nsukka*.

Federal Ministry of Education (2007). *National Curriculum for Senior Secondary School chemistry* Lagos: Government Press.

Hidi, S. & Renninger, K. A. (2014). The four-phase model of interest Development *Educational psychologist.*41 (2), 111-127

Huitt, W. G. (2000). *Using the 4MAT System to Design Web-based Instruction*.http://chiron.valdosta.edu/whuitt/papers/4matonweb.html

Kolb, D. A. (1981). *Learning styles and disciplinary differences,* In A. W. Chickering (ed.) The Modern American College, San Francisco: Jossey-Bass.

McCarthy, B., & McCarthy, D. (2006). *Teaching around the 4MAT cycle: Designing instruction for diverse learners with diverse learning styles.* Thousand Oaks, CA: Corwin Press.

Njoku, Z. C. (2010). Strategies for meeting school-based challenges in gender and STM education. Z. C. Science Teachers Association of Nigeria. *Gender and STM Education series,*1(1), 12-18

Nwosu, A. A. (2001). Gender and acquisition of science process skills among secondary school students: implications for science teaching. *42nd Annual conference proceedings of STAN. Women in science, technology and mathematics education in Nigeria,* 206-209.

Okeke, M. M. (2008). Effective Science Education Programme in the 21st Century.*Strategies for Improving Secondary Science Education in Nigeria.* Federal College of Education, Okene, Kogi State.

Philippe, M. (2017). 4MAT, a teaching strategy compactible with the brain. *Profweb multidisciplinary article and publications, laval,* 1 (2), 34-41.

Piaget, J. (1972). *Construction of reality in the child*. London: Routledge & Kegan Paul.

Pratoomtong, W. (2011). A development of science learning activities based on 4mat system and learning styles to promote multiple intelligences of sixth grade students. *Unpublished PhD thesis submitted to the Science Education at Srinakharinwirot University*

Swarat, S., Ortony, A., & Revelle, W. (2012). "Activity matters: Understanding student interest in school science". *Journal of Research in Science Teaching*, 49(4), 515-537.

UDL (2017). Universal Design of Learning. www.profweb.ca

Uyangor, S. M. (2012). The effectiveness of the 4MAT teaching model upon student achievement and attitude levels. *International Journal of Research Studies in Education* 1 (2), 43-53

WAEC Chief Examiners Reports (2014, 2015, 2016, 2017 and 2018) *Publication of WACE* office, Lagos.