

MULTIPLE INTELLIGENCES OF BIOLOGY STUDENTS WITH DIFFERENT LEARNING STYLES: INTERPLAY WITH THE FOUR MODE APPLICATION TECHNIQUE (4MAT)

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Abstract

Multiple intelligences refer to a set of skills, which allows individuals to find answers to problems they face. Multiple intelligences theory proposed that individuals have multiple human abilities or multiple intelligences based on a set of eight criteria or intelligences. In order to ensure that students develop multiple intelligences in the classroom, the teacher should continually shift the method of presentation from linguistic to spatial to musical and so on, often combining intelligences in creative way. To achieve multiple skill formation in the biology classroom, there is need to use a virile instructional approach that can engage students actively during the learning process and help them to develop multiple intelligences. The Four Mode Application Techniques (4MAT) has been identified one such teaching technique. This study investigated the effect of the 4MAT on the multiple Intelligence score of biology students with different learning styles generally and also on male and female students with different learning styles. The finding of the study showed that all students with different learning styles taught biology using 4MAT had higher multiple intelligence score than their counterparts taught using the conventional method

Introduction

The concept of human intelligences is bow been conceptualized and looked at in a more integrated way. In 1983, Gardner developed a theory called multiple intelligences that identifies and describes distinct ways in which people can represent what they know and how they can act on it. The concept of multiple intelligences is content and context oriented, focusing on human potentials, an idea related to the theme “science for all” (Nwosu, 2001).

Multiple intelligences can be used to meet three visions, which are (i) to match teaching to the way students learn; (ii) to encourage students to stretch their abilities and all their intelligences as fully as possible and (iii) to honor and celebrate diversity (Kagan and Kagan, 1998). In order to ensure that

students develop multiple intelligences in the classroom, the teacher should continually shift the method of presentation from linguistic to spatial to musical and so on, often combining intelligences in creative way. Gardner (1983) stated that if the teacher recognizes multiple intelligences in the classroom, he/she can reach more students and give those students the opportunity to demonstrate what they have understood, thereby making learners the most important focus of the educational system. This is very important especially in the sciences where learners are expected to find out facts, develop positive attitude towards science and apply scientific processes in their daily life.

Acquisitions of pertinent sets of skills as well as development of multiple intelligences are powerful tools in the classroom. There is need for multiple skill formation by students in order to be able to effectively fit into the contemporary world. Caine (2002) posited that good teachers should develop and organise classroom activities that emphasize an active role of the learners to construct their own understanding through interacting with the environment around them and arrange the activities in line with students' interest and aptitudes, bearing in mind individual differences. In order to enhance students' multiple skill formation in Biology, there is need to use a virile instructional approach that can engage students actively during the learning process and help them to develop multiple intelligences. The Four Mode Application Techniques (4MAT) has been identified as a teaching technique that can address this issue.

The 4MAT (Four Mode Application Techniques) is a model that converts learning style concepts into educational strategies. It was developed by Bernice McCarthy in 1970. The model is based on Kolb's (1984) experiential learning theory and the brain hemisphere research findings. The 4MAT is an instructional model that provides a systematic approach to organizing and delivering instructions in a manner that addresses the learning styles and hemispheric preferences of students. It is an eight-step instructional model that capitalizes on individual learning styles and brain dominance processing preferences. Inherent in the 4MAT are two major premises: one is that people have major learning style and hemispheric processing preferences (right mode and left mode); secondly, teachers should design and use multiple instructional strategies in a systematic framework to teach to these preferences in order to improve teaching and learning.

In 4MAT lesson, there is more interactive exchange of information than just giving information, there is greater appreciation for diversity as a positive outcome to enhance learning and there is deeper sense of responsibility for students during the learning process. According to Ovez

(2012), 4MAT is a conceptual framework of teaching and learning that is grounded in the works of John Dewey (experiential learning), Carl Jung (theory of individualization), and, most directly, David Kolb (experiential learning theory). 4MAT identifies four interrelated learning styles based on how individuals perceive and process new information. Its premise is that individuals learn primarily in one of the four different, but complementary ways based on how they perceive and process information (McCarthy and McCarthy, 2006). McCarthy identified these four learning styles as Imaginative Learners (Type One Learners); Analytic Learners (Type Two Learners); Common Sense Learners (Type Three Learners) and Dynamic Learners (Type Four Learners), based on Kolb's experiential learning theory. This translates to divergent, assimilative, convergent and accommodative learning styles respectively (Uyangor, 2012). In 4MAT, teachers teach according to personal differences of learner by using educational strategies suitable for each student's learning style.

4MAT also integrates learning styles with brain-based processing strategies and provides systematic model of planning instruction, which assumes that individuals learn in different but, identifiable ways and that engagement with a variety of diverse learning activities results in higher levels of motivation and performance. 4MAT model moves beyond enhancing students' self-awareness of their learning strengths and weaknesses, to a framework students can use to adapt to the variety of teaching styles and disciplines required of today's secondary school students. Based on this idea, McCarthy developed the 4MAT system and added two new views to Kolb's model concerning the way the brain works (right/left mode) (McCarthy, 1990). The 4MAT system is thus a teaching model based on research on brain function to create a practical teaching method for maximizing human learning and potential. To this effect, the present study investigated the effect of 4MAT on biology students' acquisition of multiple intelligences. The study also investigated whether the acquisition of multiple intelligences by biology students when taught with the 4MAT technique will have a gender undertone.

Gender is a set of characteristics distinguishing male and female, particularly in the cases of men and women. It is a sociological concept that ascribes certain roles to males and females. Although these roles are internalized very early in life, they vary across social, political, educational and economic dimensions. Considering the analytic and tasking nature of science, females are socialized early in life to believe that Science, Technology, Engineering and Mathematics (STEM) are meant for males (Adejeji, 2013). Studies have shown that this is not always the case. However, given the nature of interaction that occurs in a 4MAT learning environment the researchers

decided to also investigate the effect of 4MAT on biology students' acquisition of multiple intelligences along gender lines. This study therefore investigated the effect of the 4MAT on the multiple Intelligence score of students with different learning styles generally and also on male and female students with different learning styles.

The study was guided by the following research questions and hypothesis.

The following research questions and hypotheses guided the study:

- What is the multiple intelligences score of students with different learning style taught biology using 4MAT and those taught using the conventional lecture method?
- What is the difference in the multiple intelligence score of male and female students taught biology using 4MAT?
- There is no significantly effect of 4MAT on multiple intelligences of students with different learning styles.
- Gender does not significantly influence multiple intelligences of students in biology

Method

This study employed a quasi-experimental design, specifically the non-equivalent control group design. This is because the students were located in their intact classes. The school policy in the area of study does not allow disruption of classes for experimental purposes. The non-equivalent control group designed is considered appropriate in this study because in a situation where you cannot randomly assign subjects to experimental conditions, this design enables you to statistically control for initial differences. In this study, pre-test scores were used as covariates to partial out initial differences between the experimental and control group.

The study was carried out in Abakaliki Local Government Area of Ebonyi State, Nigeria. The sample for the study comprised of 139 Senior Secondary School Two (SSII) Biology students from 2 schools in Abakaliki, the Ebonyi state capital. The two schools were purposively selected from the 18 co-educational schools in Abakaliki. The purpose was to select two schools that have similar characteristics in terms of teacher qualification and teaching facilities especially well equipped laboratories. The 139 students were located in four intact classes (two in each school).

The instrument used for data collection in the study is Multiple Intelligence Inventory (MII) and Learning Style Inventory (LSI) adopted from Kolb and Kolb, 2005. The MII was re-validated by three experts from the

Department of Science Education University of Nigeria, Nsukka and trial tested on 22 Biology students within the vicinity of the study area. A reliability estimate of .74 was established for the MII using Cronbach Alpha, and this was considered adequate. The LSI is a standard instrument and was used as is.

The LSI was administered to the SSII Biology students to determine their different learning styles and to categorize them accordingly. The MII was first administered as a pre-test to the students and later as a pre-test after teaching them Biology for six weeks using the 4MAT. The students in the control group were also categorized and had the pre- and post-test. They were however taught by using the conventional method.

Data collected from the two groups were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The hypotheses were tested at 0.05% level of significance.

Result

Table 1: Mean (\bar{x}) and Standard Deviation (SD) on mean multiple intelligences score of students with different learning style taught biology using 4MAT

Methods/ Learning style	n	Pre mi \bar{x}	SD	Post mi \bar{x}	Adjusted mean SD
4MAT					
Diverging	23	142.56	19.55	186.17	28.32 172.52
Assimilating	10	125.70	17.76	195.00	29.54 191.09
Converging	21	105.95	11.66	186.00	17.79 193.49
Accommodating	17	105.00	12.08	186.35	14.26 194.39
LECTURE					
Diverging	18	112.06	14.83	120.89	14.96 124.85
Assimilating	26	120.77	11.55	180.85	15.21 179.78
Converging	11	125.45	15.83	136.91	20.07 133.14
Accommodating	13	111.31	25.47	122.92	27.17 127.32

Note: Pre mi = Pretest score and Post mi = Posttest score on Multiple Intelligence

Data in Table 1 showed that students with different learning styles taught biology using 4MAT had higher post-test multiple intelligence score than their counterparts taught biology using the conventional lecture method. The result also revealed that in the 4MAT group, the differences in the multiple intelligences of students in all the learning styles were not significant, while in the lecture group, only students with assimilating learning

style had high multiple intelligence score. Evidence from literature indicates that students with assimilating learning style actually prefer learning through conventional lecture method. This accounts for their consistent high multiple intelligence scores.

Table 2: Mean (\bar{X}) and Standard Deviation (SD) on Influence of Gender on the Multiple Intelligences of Students taught Biology using 4MAT

Gender	N	Pre MI		Post Mi		Adjusted Mean \bar{X}
		\bar{X}_1	SD ₁	\bar{X}_2	SD ₂	
Male	29	119.69	21.87	182.79	20.04	182.90
Female	42	120.37	22.77	190.59	22.69	190.52

Data in table 2 showed that male students taught biology using 4MAT had adjusted mean score of 182.90 while their female counterparts had adjusted mean score of 190.52. The result showed that female students had higher multiple intelligence score than their male counterparts when taught biology using 4MAT.

Table 3: Analysis of Covariance Table for Students' Multiple intelligences Scores in Biology

SOURCES OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
Corrected model	127579.535	16	7973.721	25.171	.000
Intercept	18948.742	1	18948.724	59.817	.000
Pre MI	9644.268	1	9644.268	30.445	
Method	88667.455	7	12666.779	39.986	.000
Gender	1325.536	1	1325.536	4.184	.000
Method x Gender	5483.216	7	783.317	2.473	.043
Error	38646.997	122	316.779		.020
Total	4067888.000	139			
Corrected total	166226.532	138			

Data in Table 3 showed a statistical significant main effect of instructional method on multiple intelligence (MI) score of students in biology $F(7, 138) = 39.986, p < .000$. The null hypothesis therefore, was rejected indicating that there was significant difference in the MI scores of students with different learning style taught biology using 4MAT and those taught using the conventional lecture method. The students taught with 4MAT had all round higher MI than those taught with the conventional method.

Data in Table 3 showed a statistically significant main influence of gender on students' multiple intelligences in biology $F(1, 138) = 4.184$, $p < .043$. The null hypothesis therefore, was rejected, indicating that there was a significant difference in the MI score of male and female students taught biology using 4MAT. The female students had higher MI scores than their male counterparts.

Discussion

The findings of the study showed that all students with different learning styles taught biology using 4MAT had higher multiple intelligence scores than their counterparts taught using the conventional method. The finding was probably due to the fact that the 4MAT instruction involves activities that engaged the functions of the two hemispheres of the brain, which enables them to perform various activities in the learning process. The students in the 4MAT group were involved in many activities and experiments that required the use of multiple intelligences, these probably enhanced their MI. This finding is in line with the observation of Pratoomtong (2011) and Ovez (2012) who stated from the findings of their study that science learning activities based on 4MAT increased the multiple intelligence score of students with different learning styles in science and mathematics. This shows that 4MAT is an effective instructional method.

The result of the study also showed that female students taught biology using 4MAT had higher multiple intelligence scores than their male counterparts in biology. This could be as a result of the nature of biology instruction and activities involved in the 4MAT mode, this took care of the academic needs and multiple intelligences of all students with different learning styles, and gave the female students opportunity to perform better than their male counterparts, mostly because the activities offered the female students a deeper understanding and insight into the topics studied. This is confirmed by literature evidence from the study of Onimisi & Nzewi (2012) who reported from their studies that a teacher's style has a lot of influence on how male and female students learn. The female students were enabled to learn in a non-threatening environment, and literature has shown (Okoyefi & Nzewi, 2013 and Nzewi 2015) that once that classroom environment is non-threatening, female students accomplish more. Thus the compounding influence of gender which makes female appear to lack behind in science learning was not apparent.

Implications of the Study

The findings of this study have implications for education in general and Science Education community in particular. The findings of this study have shown that student-centered instructional strategies, one of which is the 4MAT, actively engage diversity of learners in the learning process and enhance their acquisition of multiple intelligences. 4MAT was able to engage the function of the two hemispheres of the brain and address the needs of students with different learning styles, thereby enhancing their multiple intelligences; hence, its use should be encouraged in the teaching and learning of biology. More so, in view of the fact that 4MAT instructional model was effective in addressing the needs of male and female students, and improved their multiple intelligences, it is recommended that, Science teachers incorporate this strategy. This could facilitate effective learning and help students acquire tools that are necessary to survive in the globalized world. Most importantly, it could be a basis for narrowing the gender gap in Science participation since female students appear to have benefitted more from the method.

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