Effects of Herrmann's Whole-Brain Model on Retention among Secondary School Physics Students in Zaria Education Zone Kaduna State, Nigeria

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ABSTRACT

This study investigated the effects of Herrmann's Whole-Brain Model on retention among secondary school physics students in the Zaria Education Zone, Kaduna State, Nigeria. Two research objectives, two research questions and two null hypotheses guided the conduct of the study. The study used a pretest, posttest, and post-posttest quasi-experimental design. Two academically equivalent schools out of the 15 public co-educational senior secondary schools (N=1,422) in the zone, with a total number of 228, constituted the sample for the study. A validated and tested reliable instruments Physics Performance Test (PPT) with reliability coefficient of 0.78 developed by the researcher was used for generating data. Research questions raised were answered using means and standard deviations, while the null hypotheses were tested using a t-test statistical tool at a 0.05 level of significance with the aid of the computer software Statistical Packages for Social Sciences (SPSS version 21). There is a significant difference between the mean retention scores of students taught physics concepts using HWBM and those taught the same concepts using the lecture method in favour of the experimental group. There is no significant difference between the mean retention scores of male and female students taught physics concepts using HWBM. The study concluded that HWBM is effective in the teaching and learning of physics in senior secondary schools and it is gender-friendly. Based on the findings, the following recommendations were made, among others: Teachers should employ HWBM in the teaching of Physics in senior secondary schools to enhance students' retention ability. Both coeducational and single-sex schools should be encouraged to use HWBM as it was found to be gender-friendly in this study.

KEYWORDS: Physics, Wave Concepts, Herrmann's Whole-Brain Model, Retention

Introduction

The purpose of education is to teach learners to become more efficient thinkers, making smart social, emotional, and academic decisions (Brown, 2012). The major aim of teaching science in schools is to facilitate students' acquisition of science process skills and to promote the understanding of concepts being taught with a view to applying them to real-life situations

(Afolabi & Akinbobola, 2012). The study of science has been of great importance internationally for sustainable and socio-economic development as well as technological advancement of a nation like Nigeria. Success in science education hinges on success in various science subjects, such as physics.

Physics is one of the core science subjects in Nigerian secondary schools. Physics is an aspect of science that helps to explain the cause-effect relationships of matter and energy, and their application to natural phenomena (Atadoga, 2001). Physics is identified as the most utilized basic science subject in most technology and technology-related professions. Physics concepts and techniques underpin the understanding of other disciplines (Akingbade & Omotade, 2013). Physics encompasses many fields of study in science and technology, including mechanics, electricity, heat, wave, optics, cryogenics, astrophysics, plasma physics, nuclear physics, and solid state physics. Physics is a cross-cutting discipline that has applications in many sectors of economic development, including health, agriculture, water energy, and information technology (Josiah, 2012). Physics, as a science subject, has been acknowledged as a pre-requisite for the study of several courses in universities (Bello, 2015). Hence, physics must be taught in such a way that students will be able to retain what they have learned and be able to retrieve it when needed. These posters show the importance of retention in the teaching and learning of physics.

Retention as one of the important variables of the study refers to the ability of a learner to recall, remember and recollect a body of knowledge after passing through instruction (Yero 2011). In other words, retention refers to what is learned minus what has been forgotten. The theories of forgetting make it clear that forgetting takes place as a result of the passage of time. As such, the students' retention ability should be strengthened through memorization, practice and activity based learning. Knowledge is acquired through perception and perception takes place through the senses. Knowledge develops if the information perceived is retained in the mind. But if the information is destroyed or fades away quickly, then knowledge cannot develop. Thus, retention is the preservation factor of the mind (Godwin, 2014). Isa (2018) opined that poor retention ability among science students in our schools queries the methodology of instruction. Hence, the use of instructional strategy is found to be significantly effective in boosting retention in science. As such, researchers such as Clark (2016) and Sontillano (2018) advocate the use of brain-compatible models, one of which is Herrmann's Whole Brain Model (HWBM).

Herrman's Whole Brain Model is a brain-compatible model that defines learning styles as a function of brain chambers (parts) and puts emphasis on learning with the whole brain. Herrmann (1988) proposes that the brain is divided into an upper part and a lower part based on learning characteristics, both of which are further subdivided into right and left portions. The upper part deals with abstract and conceptual concepts, while the lower part deals with emotional and intrinsic ideas. The left-upper part deals with logic and quantity, whereas the left-lower parts deal with sequence and organization. On the other hand, the right-upper part deals with conceptual and visual notions, whereas the right-lower part deals with interpersonal and emotional concepts (Bawaneh et al., 2012).

Herrmann (2000) classified learning styles based on the functions controlled by each chamber of the brain and identified four divisions within the brain, each of which was associated with a certain learning style. (Bawaneh et al., 2010), as shown in Figure 1 below.

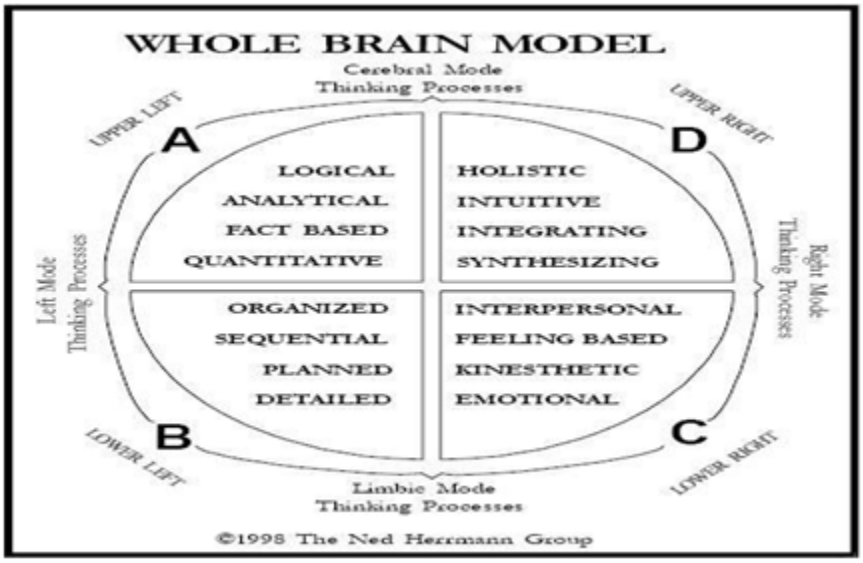

Figure 1: Brain Division by Herrmann's Taxonomy (Herrmann, 2000).

Herrman's Whole Brain Model is based on Gardner's theory of multiple approaches to learning, which holds that every individual has different abilities in each area and that incorporating all intelligences into the learning process maximizes learning potential. HWBM is also rooted on Kovalik's Integrated Thematic Instructional Design Theory which holds that Students need to explore the new and different, and to be open to new ideas requiring confidence that one is in a safe environment, one in which mistakes and difficulty in understanding/doing something are considered just part of learning, not an opportunity for sarcasm and put-downs. However, Gender has been identified as one of the predictor variable that may be factored in students' retention ability and captured the interest of educators in Nigeria, especially now that gender equity is being emphasized in many quotas.

According to Filgona and Sababa (2017), gender is the range of physical, biological, mental and behavioural characteristics pertaining to and differentiating between the feminine and masculine (female and male) population. In other words, gender does not refer to only the sex difference between male and female, but the entire physical, biological, mental, and behavioural characteristics that differentiate between male and female. Gender, as a concept, has become a topic of discussion and has captured the interest of educators in Nigeria due to the socio-cultural differences manifested between males and females, in which some vocations and professions have been voluntarily surrendered to men, while others have been surrendered to women. Differences in treatment through education created and sustained a gender gap that also became visible in the science-related disciplines.

Statement of the Problem

Physics as a core science in senior secondary schools plays important roles in equipping students with the necessary scientific skills for a progressive society and forms bedrock for scientific knowledge and technology upon which the development of a nation based. Despite the

importance of Physics to national development, the subject is dwindling in terms of knowledge retention and patronage over years. It is clear from research findings that the subject has been suffering from low patronage and poor academic performance (Consequence of poor retention ability) in both internal and external examination within and outside the country (Godwin & Okoronka, 2015). Average performance was reported by the WAEC chief Examiner for candidates for Physics in (2015), (2016), (2017), and (2018) where Lack of mastery of subject matter, Lack of understanding of scientific terms, Poor computation and skills were identified as the candidates' weaknesses (https://www.waecgh.org/EXAMS/ChiefExaminersReport.aspx) retrieved on 12th Oct, 2020. Based on the above reports, poor academic performance in Physics has been identified over years and may be attributed to the poor retention ability among the students.

Isa (2018) opined that information stored in the long term memory can be described as information retained and could be measured through performance. In other word, learner must retain the learned materials for some moment before he or she can be able to retrieve the information and perform positively in any corresponding evaluation task. Hence, the students' retention ability should be strengthened. As such, this study examined whether retention could be enhance through combined direct instruction, sharing, memorization, practice and immediate feedback as affair in HWBM.

Objectives of the Study

The objectives of the study are to:

a) investigate effects of Herrmann's Whole-Brain Model on retention ability among Physics students in Zaria education zone Kaduna state, Nigeria; and

b) find effects of Herrmann's Whole-Brain Model on retention ability of male and female Physics students in Zaria education zone Kaduna state, Nigeria;

Research Questions

The following research questions guided the direction of the study;

a) Is there any difference between the retention levels of the Physics students exposed to Herrmann's Whole-Brain Model and those exposed to lecture method?

b) What is the difference between the retention levels of male and female students taught Physics using Herrmann's Whole-Brain Model?

Null Hypotheses

The following null hypotheses was formulated and tested at 0.05 level of significance.

$H0_1$: There is no significant difference between the retention levels of Physics students taught Physics concepts using Herrmann's Whole-Brain Model and those taught same using lecture method.

$H0_2$: There is no significant difference between the retention levels of male and female students taught Physics using Herrmann's Whole-Brain Model.

Research Method

The design for this study is pre-test, posttest, and post-posttest quasi-experimental research design which involves the tagging of two groups, one as experimental group and the other as control group. The experimental group (EG) was exposed to the wave concepts using HWBM for six weeks while the control group was exposed to the same concepts using lecture method for the same period.

The population of this study comprised of all public co-educational Senior Secondary Schools (SSII) physics students in Zaria Education zone with total population of 1,422 students out of which 787 were males and 635 were females.

The sample was selected using simple random sampling. The name of each of the 15 senior secondary co-educational schools were written in a piece of paper, squeezed, put in a container and shuffled. One piece of paper was picked at a time and reshuffled in each case until four papers were selected. The names that appeared on those papers were the sampled schools. Four schools were selected at random. The sampled schools were pretested using Physics Performance Test (PPT) to ascertain the academic equivalent or parity among the groups and reduce internal validity threat which may occur due to the non-random assignment of subject into group. The scores of the schools pretested were analysed using analysis of variance (ANOVA) by which two academically equivalent schools in the wave concepts A and B were randomly tagged as experimental and control group respectively using tossing of coin.

Physics Performance Test (PPT) comprises 30 multiple choice test questions (one mark for each). Each item of the instrument carried four options (A, B, C, & D) with one correct answer. The instrument was administered by the researcher with the help of two teachers during the pretest, post-test and post-posttest for the purpose of generating data.

RESULTS

Research Question One: what is the difference in the retention level among Physics students exposed to Herrmann's Whole-Brain Model and those exposed to lecture method?

To answer this research question, mean and standard deviations of performance scores were computed. The post-posttest scores of experimental and control groups are subjected to descriptive statistics. Mean and standard deviation are computed and used to draw Table 1

Table 1: Mean and Standard Deviation of Post-posttest Scores of the Experimental and Control Groups

Groups	N	Mean	Std. Deviation	Mean Difference
Experimental	123	20.65	3.69	
				11.73
Control	105	8.92	2.64	

Results from Table 1 show that the post-posttest mean scores for the experimental and control groups are 20.65 and 8.92 respectively with the mean difference of 11.73 and the standard deviations for the experimental and control group are 3.69 and 2.64 respectively. This means the

experimental group retained higher than the control group, and this could be attributed to the different treatments received by the groups.

Research Question Two: Is there any difference in the retention ability of male and female students taught Physics using Herrmann's Whole-Brain Model?

To answer this research question, mean and standard deviations of performance scores are considered. The post-posttest scores of the experimental group are sorted according to gender and subjected to descriptive statistics. Mean and standard deviation are computed and used to draw Table 2

Table 2: Mean and Standard Deviation of Post-Posttest Scores of Male and Female Students Taught Physics Concepts Using HWBM

Groups	N	Mean	Std. Deviation	Mean Difference
Male	52	19.00	3.81	
				0.34
Female	71	19.33	3.31	

Results from Table 2 show that the post-posttest mean scores for the male and female students are 19.00 and 19.33. respectively with the mean Difference of 0.34 and the standard deviation for the male and female students are 3.81 and 3.31 respectively. This means that the female students retained very slightly higher than the male students, and this may be attributed to the gender differences among male and female students in the experimental group. However, the difference appears to be negligible.

Testing Null Hypotheses

After answering the research questions, the stated null hypotheses are tested at $p \leq 0.05$ Levels of significance:

$H0_1$: There is no significant difference between the retention ability of Physics students taught Physics concepts using Herrmann's Whole-Brain Model and those taught same using lecture method.

To test this hypothesis, the mean academic performance scores of students in experimental and control groups are subjected to t-test statistic and summary of the analysis is shown in Table 4

Table 3: Summary of t- Test Analysis of Post-Posttest Scores of Experimental and Control Groups

Groups	N	Mean	S.D	T	Df	P-value	Decision
Experimental	123	20.65	3.69				
				27.18*	226	0.00	*Significant
Control	105	8.92	2.64				

*Significant at $\alpha = P < 0.05$

The results from Table 3 shows that the p-value is 0.00 which is lower than 0.05 level of significance, Hence the null hypotheses which states that there is no significant difference

between the retention ability of Physics students taught Physics concepts using Herrmann's Whole-Brain Model and those taught same using lecture method is rejected.

$H0_2$: There is no significant difference between the retention ability of male and female students taught Physics using Herrmann's Whole-Brain Model.

To test this hypothesis, the mean post-posttest scores of male and female students are subjected to t- test statistic and summary of analysis are shown in Table 4

Table 4 T-test Analysis of Post-Posttest Mean Scores of Male and Female Students in the Experimental Group

Groups	N	Mean	S.D	T	Df	P-value	Decision
Male	52	19.00	3.81				
				0.51	121	0.60	^Not significant
Female	71	19.33	3.31				

^Not Significant at $\alpha = P > 0.05$

The t-test analysis from Table 4 shows that the p-value is 0.60 which is higher than 0.05 level of significance, Hence the null hypotheses which states that there is no significant difference between the retention ability of male and female students taught Physics using Herrmann's Whole-Brain Model is retained.

Discussion of findings

The results of the analysis are presented in Tables 1 and 3. The results show that the experimental group has higher retention ability of the concepts taught than the control group. This finding is supported by Howard-Jones (2014), who proved that words accompanied by gestures yield better retention. This finding is also in line with Sontillano (2018), who concluded that there was a greater retention of the topics learned when taught using whole-brain teaching techniques compared to the lecture method. The significant difference in retention level of the experiment and control groups in favour of the experimental group could be due to the fact that HWBM involves the use of multiple learning styles in the classroom. During the treatment of the experimental group, the researcher observed that the time allocated for individual tasks allowed the students to study the individual task papers step-by-step and repeatedly, which in turn solidified the information in their brains. The researcher also observed that the use of the Scoreboard game helped the students to internalize the material learned, which in turn aided their retention abilities. This was another significant advantage of the experimental group over the control group, as Sontillano (2018) makes evident that engaging students to play the role of teacher (answering questions inclusive) facilitates retention.

Table 2 and 4 show the analysis of the post-posttest of male and female students in the experimental group. From the results of this analysis, there is no significant difference between the mean retention scores of male and female students taught physics concepts using HWBM (experimental group). This finding reveals that the use of HWBM is gender friendly. The insignificant difference in retention levels between male and female students in the experiment

group could be due to the fact that both male and female students were given equal opportunity to embrace the various learning styles involved in HWBM, including the Scoreboard game, which aids their retention abilities, as Sontillano (2018) shows that engaging students to play the role of teacher (answering questions inclusive) facilitates retention. The time allocated for individual tasks allowed both male and female students to study the individual task papers step-by-step and repeatedly, which in turn solidified the information in their brains. These might be reasons for the insignificant difference in retention levels between male and female students in the experimental group.

Conclusion

Based on this study, the following conclusions were made:

HWBM promote meaningful learning and facilitate retention of Physics concepts in secondary schools. HWBM is gender friendly as it promotes retention of Physics concepts among male and female students in secondary schools.

Recommendations

Based on the findings of this study, the followings recommendations are made;

1. The use of HWBM should be encouraged among secondary school Physics teachers because from this study, HWBM was found very effective in enhancing meaningful learning and facilitate retention of physics concepts in secondary schools.

2. Both coeducational and single sex schools should be encouraged to use HWBM as it is found gender friendly in this study.

3. Physics teachers should adopt the use of HWBM in teaching Physics in senior secondary school to enhance retention of Physics concepts.

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