VEE-MAPPING STRATEGY: A GENDER RESPONSIVE TECHNIQUE FOR IMPROVING SCIENCE ACHIEVEMENT

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Abstract

This study investigated the effects of vee-rnapping strategy, as a gender responsive technique, on basic science achievement of male and female students from junior secondary schools Kaura Local Government Area of Kaduna State. Three research questions were raised and two null hypotheses formulated to guide the study. A randomized pre-test-post-test control group design was used. Forty male and 40 female JSS two students in two public schools constituted the sample. The schools were selected using the simple random sampling technique. The students in intact were also randomly assigned to experimental group and a control groups. The instrument for data collection was a Basic Science Achievement Test (BSAT) with a reliability coefficient of 0.78 using the test-re-test method. The research questions were answered using mean and standard deviation while the hypotheses were tested using ANCOVA at 0.05 level of significance. Findings of the study; revealed no significant difference between the post-test achievement mean scores of male and female students in Basic Science Achievement Test among others. It was recommended that basic science teachers should employ the vee-mapping strategy as a gender responsive- strategy for be enhancing students' thinking capacity for improved achievement in basic science.

Introduction

Science and technology has become such a critical factor of economic and social development that life without it can no longer be contemplated. In addition to the fact that, through science and technology a nation develops its

manpower in critical areas as Engineering, Architecture, Medicine, Agriculture and other science based professions and technologies. The benefits of science and technology have traversed every conceivable sphere of human life. For instance, the ability of human beings to produce high quality goods and services has improved tremendously. New drugs and vaccines for treatment of very dangerous diseases have also been produced for enhancing longevity. High yielding varieties of crops and animals as well as disease-resistant varieties have been developed. Through science and technology, transportation and communication have improved remarkably.

In recognition of the critical role science and technology play in socio-economic transformation of nations, the federal government of Nigeria through its National Policy on Education (Federal Republic of Nigeria [FRN], 2013) emphasizes the need for the teaching and learning of science subjects at all levels of education. With the policy, students, irrespective of any differences, real or imagined must be taught science from the lower basic education level to upper basic education level using appropriate teaching strategies capable of motivating them into studying science-related courses at the tertiary level of education The government has also made other laudable efforts to boost science education, such as establishing more Universities of Technology, financing long vacation courses to enhance the teaching and learning of science, mathematics and technology courses, mandating that university admissions should be in the ratio of 60:40 in favour of science and its related courses and for students to proceed to senior secondary, they must study and pass science at the basic level of education.

Despite these efforts by the government, Nigerian students have been under achieving in science courses at all levels of education (Ozoji, 2010:West African Examinations Council [WAEC], 2011-2016). Gender differences have been identified as one of the critical factors responsible for the differential achievement of students in science with males out-performing females. The low level of enrolment and achievement in science by girls have been established by researches over the years (Iweka, 2006; Okeke, 2008; WAEC, 2006-2009; Busola, 2011).Gender disparity in science and technology, enrolment and achievement may not be unconnected with socio-cultural factors and gender stereotyping which consider females as not being as cognitively able to study science, technology and mathematics- related courses as their male counterparts. This is at variance with the policy of the Nigerian government which emphasizes the provision of equal educational opportunities for every Nigerian child (FRN, 2013), as well as, the Millennium Development and Sustainable Developments Goals of promoting gender equity in educational opportunities and discouraging discrimination in education, respectively.

However, findings on influence of gender on science and technology achievement are inconclusive. For instance,Uguma and Akpama (2005), Iweka (2006), Adebayo (2007), Ezeliora (2002), found no significant differences between achievement mean scores of male and female students taught science concepts. Ajibade (2000), in his study on sex differences and students' academic performance in secondary schools found that female students performed better than their male counterparts while Iweka (2006) found that male students out-performed their female counterparts in science achievement. However, the report by Nworgu (2004), Abiam and Odok (2006).Vanhear (2008), Martins (2008) and Vale (2007) show that even though gender differences in mathematics and science exist, they have declined over the years.

The factors advanced as being responsible for female under achievement in science- related courses include girls' under-estimation of their ability (Eriba, 2005), lack of confidence in their ability (Longbap&Maichibi, 2006), and the differential treatment of girls from boys by teachers in their strategies and expectations (Omirin, 2005). These are contrary to the objectives of the National Policy on Education (FRN, 2013), and National Policy on Science and Technology Education both of which emphasize equality of freedom, equality of rights and obligations before the law and education for every citizen irrespective of gender. It is also contrary to the emphasis by World Bank (1993) on the importance of investing on girls' and women's education because it empowers them to play economic, social and political roles in the society. It is therefore imperative for science teachers to employ gender responsive techniques in science classes to enhance students' achievement in science related courses. Moreover, it has been reported that teaching method is another critical factor that causes underachievement, particularly in the sciences because of the abstract and difficult nature of science concepts. Little wonder, Akinbola (2005) calls for a paradigm shift in science teachers' perspectives, approaches and strategies. In the same vein, Allen (2007) emphasizes that the most effective way of learning is through participation and calls on educators to create opportunities for students to participate in their learning. This is critical, more so, with the issues of cultural and societal factors hindering the enrolment and participation of students (particularly females) in science, mathematics and technology- related courses, government's emphasis on achieving the Sustainable Development Goal of right of every individual to education without discrimination, gross inadequacy of equipment and materials for effective science instruction. The Present system of teaching of science and technology appears to have failed in fulfilling the need of the hour. The need of the hour is the teaching learning process which is gender responsive, which develops the analytical ability of males and females alike, critical thinking, application of knowledge,

ability to synthesize new knowledge, and the ability to evaluate synthesized knowledge. In essence, the type of teaching/learning process that should be put in place is that which promotes the higher order thinking skills and creativity of both male and female students. The traditional lecture method must be replaced by more gender-friendly, more proficient and more promising methods regarding the development of higher order thinking skills such as the vee-mapping, concept mapping, mind mapping, problem-solving methods. Vee- Mapping strategy has been shown to improve the achievement scores of students exposed to it (Gaiya, 2013).

The vee-mapping strategy as a gender responsive strategy enhances thinking and cognitive growth of students. The actual process of constructing a vee-map involves three mental processes (thinking, feeling and acting). In contrast with "traditional" teaching and learning where the students are asked to represent their knowledge through ways which rely mainly on memory, in order to regurgitate chunks of information (surface learning). When students are asked to represent their knowledge by constructing vee maps, they may be going through a process of metacognition (deep learning). Metacognition entails mulling, connecting, rehearsing, expressing, assessing, reflecting, revising and learning. Actually, when one is constructing a Vee-map, one goes through these processes and this is why Vee- mapping facilitates meaningful learning and challenges rote learning.

This study, therefore, investigated the vee-mapping strategy, as a gender responsive technique for improving science in Kaura local government area of Kaduna State, Nigeria To achieve this purpose, the following objectives were stated, to:

1. .determine the pre-test Basic Science Achievement Test Mean Scores of JSS 11 students in experimental and control groups exposed to vee-mapping strategy and lecture method, respectively;

2 find out the effect of vee-mapping strategy on JSS 11 male and female students' achievement in Basic Science Achievement Test; determine the post-test achievement mean scores of JSS 11 students in experimental and control groups in Basic Science Achievement Test.

Research Questions

1. What are the pre-test achievement mean scores of the experimental and control groups in Basic Science Achievement Test?

2. What are the post-test achievement mean scores of the experimental and control groups in Basic Science Achievement Test?

3. What are the post-test achievement mean scores of SSII male and female student exposed to vee-mapping strategy in Basic Science?

Hypotheses

1 There is no significant difference between the post-test mean scores of experimental and control groups in BSAT.

2. There is no significant difference between the post-test mean scores of JSS II male and female students exposed to vee-mapping strategy BSAT

Research Design

The design for the study was a randomized pre-test-post-testcontrol group design. The design involves two groups (experimental and control) with the members of the group assigned to the groups by the researcher. The pre-test and post-test scores of the experimental group were used to determine the effect of the treatment on the dependent variable. The pre- test scores of the experimental and control groups were used to ascertain their compatibility in terms of their means and standard deviations. This serves as a means of controlling extraneous variables in true experimental designs. Pre-test was essentially useful in providing control over differential subject characteristics because it was only through a pre-test that initial equivalence or homogeneity of the groups was demonstrated.

Population and Sample

The population of the study comprised 13 public schools with a population of 3982 JSS II students comprising 2097 male students and 1885 female students in Kaura Local Government Area of Kaduna State (Kaduna State Ministry of Education. 2016).

Sample

A sample of 80 JSS II students comprising 40 male students and 40 female students from two were used in the study.

Sampling Technique

The simple random sampling technique was used to select two schools from 13 public junior secondary schools. The students were randomly assigned to experimental and control groups (40 males and 40 females in each group). The choice for JSS II students for the study was because the JSS II students were fully part of those benefiting from the implementation of the New Basic Science and Technology Curriculum.

Instrument for Data Collection

The Basic Science Achievement Test was used in this study. It comprised two sections (A and B). Section A sought information on the personal data of the

students with respect to gender and school name. Section B sought information on students' achievement in Basic Science. The section consisted of twenty five questions drawn from two topics in Basic Science curriculum. The test consisted of multiple choice questions. The students were required to choose the correct answers from the options (a-e), listed against each question. In every question, only one option was correct while other options were wrong. The questions were drawn from the Junior Schools Certificate Examination (JSCE) past question papers in Basic Science and table of specification was used to spread questions related to the topics taking cognisance of the various cognitive levels, such as, knowledge, Comprehension and Application. The total mark scored was 25 while the least mark was 0 which was converted to 100%. The instrument was administered to both experimental and control groups as pre- test and post-test.

The treatment package was a vee mappmg instructional strategy for the JSS II students in Basic Science developed by the researchers. The package covered the topic "Thermal energy, Crude oils and Petrochemicals" under the aspect of Science and Development which was divided into six lessons. First was the introduction to Vee map, and second was the use of the Vee-mapping strategy where a focus question was posted and a Vee map was used to answer the question. The students could proceed further to the next lesson on the condition that they can satisfactorily answer another focus question using the Vee Map. The second lesson was on Thermal energy and the third, crude oils and petro- chemicals. The BSAT instrument was subjected to content validity by an experienced Basic Science teacher and a science educator in the Department of Science and Technology Education, University of Jos. The reliability index calculated was 0.87,using the test-retest method and was considered as adequate for collecting data for the study.

Administration of Pre-test

Prior to the commencement of the conduct of the research in the sampled schools, the BSAT was administered to the experimental and control groups. Responses of students in the two groups were scored and their means calculated to determine their entry points. This was used by the researchers to statistically equate the two groups before their exposure to different methods of teaching.

Administration of Treatment

Two double-lessons of 80 minutes per week were taught both the experimental and control groups in the selected topics in Basic Science and Technology. Special arrangement was made with other subject teachers for swapping of periods so as to have enough time and space school time table for the double lessons.

The experimental group was taught using the Vee Mapping strategy by two appropriately trained research assistants, and the control group and the control group by two other research assistants using the lecture method. The content (Thermal energy, Crude oils and Petrochemicals) and objectives of the lessons for the two groups were the same except for the method of instruction.

Administration of Post-test

The instrument used for collection of post-test scores was the BSAT. The post-test was administered to both experimental and control groups a week after the end of the teaching exercise. The scores based on students' achievement were used by the researchers to determine the effects of the intervention on gender and achievement of students in Basic Science.

Results

The results are presented in Tables on the basis of the research questions and hypotheses that guided the study as follows:

Research Question One.

What are the pre-test achievement mean scores of junior secondary school two (JSSII) students in experimental and control groups in Basic Science?

Table 1: Basic Science Pre-test Achievement Mean Scores of Students in Experimental and Control groups

Group	No of Students	Mean	Standard Deviation
Experimental	40	53.25	11.06
Control	45	49.37	7.52

Table 1 shows that the BSAT pre-test mean scores of experimental and control groups were 53.25 and 49.37 respectively. This indicates that both experimental control groups had average achievement before exposing them to different teaching strategies.

Research Question Two

What are the post-test achievement mean scores of the experimental and control groups of JSSII students in Basic Science Achievement Test?

Table 2: Basic Science Post-test Achievement Mean Scores of JSS II Students experimental and control groups.

Group	Number of Students	Mean	Standard Deviation
Experimental	40	66.00	11.55
Control	40	54.37	6.42

The results in Table 2 show that post-test mean scores of students in the experimental and control groups are 66.00 and 54.37 respectively.

Research Question Three

What are the post-test achievement mean scores of JSS 11 male and female students exposed to vee-mapping strategy in Basic Science Achievement Test?

Table 3: Post-test Achievement mean scores of JSS II male and female students exposed to Vee- Mapping strategy.

Gender	Number of Students	Mean	Standard Deviation
Males	20	66.50	13.67
Females	20	65.50	9.30

Table 3 shows that the Basic Science Achievement Test mean scores of JSS II male and female students exposed to Vee-Map instructional strategy were 66.50and 65.50 respectively. This indicates that gender did not affect students' achievement when Vee-Mapping instructional strategy was used.

Hypothesis One:

There is no significant difference between post-test mean achievement scores of male and female students exposed to vee-mapping and those not exposed to vee-mapping strategy.

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Table 4: Univariate Analysis of Co-Variance (ANCOVA) Comparing the Mean Achievement Scores of Male and Female Students Exposed to Vee-Mapping Strategy.

Source	Type III sum of Squares	df	Mean square	F	P	Remark
Corrected Model	2788.437[a]	3	929.479	10.479	0.000	
Intercept	27730.125	1	27730.125	312.974	0.000	
Gender (males and females)	**15.313**	**1**	**15.313**	**0.175**	**0.679**	**Not sgnificant**
Error	6733.750	76	88.602			
Total	149662.5	40				
Corrected total	4761.0935	39				

a. R Squared = .293 (Adjusted R Squared = .265)

The results in Table 1 indicate that the Sum of Squares of male and female students was 15.313,df 1, Mean Squares was 15.313 with F-value of 0.173 and p-value 0.679 at 0.05 level of significance. This therefore shows that, the mean achievement scores between male and female students were not significant. The null hypothesis was therefore retained. The conclusion was that, there was no significant difference between the post-test mean achievement scores of male and female students exposed to vee-mapping strategy.

Hypothesis Two:

There is no significant difference between post-test mean achievement scores of JSS two students in experimental and control groups.

Table 5: Univariate Analysis of Co- Variance (ANCOVA) Comparing the Mean Achievement Scores of Experimental and Control Groups.

Source	Type III sum of Squares	df	Mean square	F	P	Remark
Corrected Model	2788.437[a]	3	929.479	10.479	0.000	
Intercept	27730.125	1	27730.125	312.974	0.000	
Group (Exp. & Cont.)	595.125	1	595.12	6.717	0.011	significant
Error	6733.750	76	88.602			
Total	299325.000	80				
Corrected total	9522.187	79				

a. R Squared = .293 (Adjusted R Squared = .265)

The results in Table 2 indicate that the Sum of Squares of experimental and control was 595.125, df 1, Mean Squares was 595.125, with F-value 6.717 and p-value 0.011 at 0.05 level of significance. This therefore indicated that, the mean achievement scores between experimental and control groups was significant. The null hypothesis was therefore rejected. The conclusion was that, there was statistically a significant difference between the basic science mean achievement test scores of experimental and control groups.

Discussion

One of the main findings of this study was that male and female students exposed to Vee-mapping instructional strategy did not differ significantly in their mean achievement scores in Basic Science and technology. The result obtained from the study in Table 3 showed that the male students exposed to vee-mapping strategy had achievement mean score of 66.50 while the females

got 65.50. For those not exposed to Vee-mapping strategy however, the male students had an achievement mean score of 53.00 while the females got 55.75. This implies that gender gap in science achievement is reducing. This is in line with the view of Martin et al., (2008) who submitted that differences between boys and girls in area of achievement in sciences are now very minimal. The findings agree with Nworgu (2004) who observed that exposing students to appropriate activities reduces gender gap in science. From the present study, one can say that gender has no influence on students' achievement in Basic Science. Even though this finding is not consistent with Busola (2011) who observed that tJsest. male students achieved higher than their female counterparts in chemistry which is a science subject and whose foundation is Basic Science.

From Table 5 the findings of the study show that there was a significant difference between the post-test achievement mean scores of students taught Basic Science using vee- nmapping strategy (66.00) than those that were exposed to conventional method (54.00). The difference shows that vee-mapping strategy had more positive effect on mean achievement scores of students in Basic Science. This finding is consistent with the study carried out by Gaiya (2013) which showed an improvement in the mean achievement score of students that were exposed to vee-mapping strategy. This result agrees with Allen (2007) who emphasized that the most effective way of learning is through participation and calls for educators to make special efforts to create opportunities for students to participate in their learning. The results obtained in this study could be attributed to active participation by the learners in using the materials during the practical experience to get answers to the focus questions. This could help them retrieve what was learnt. It could equally be attributed to the gender- friendliness of the vee-mapping strategy which worked as a gender responsive strategy for enhancing students' achievement in basic science and technology.

The reduction in gender gap achieved in this study has now shown that female students can enjoy science to the same degree as their male counterparts as well as achieve well in the subject. This finding refutes the common misconception of male superiority over females in science achievement and the general belief that males are more cognitively endowed than females with regard to science learning and achievement.

Conclusion and Recommendations

It was concluded that the vee-mapping strategy is a gender responsive technique which is capable of enhancing female students' achievement in basic science. It was therefore recommended that teachers should employ vee-mapping strategy to enhance the critical thinking skills, cognitive growth and achievement of male and female students alike in science classrooms.

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