
GENDER DIMENSION IN ASSIMILATION OF ENERGY CONCEPTS USING SENSORY STIMULATION AND INQUIRY STRATEGIES AMONGST JUNIOR SECONDARY STUDENTS IN NASARAWA STATE, NIGERIA

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Abstract

The study investigated gender dimension in assimilation of energy concepts using sensory stimulation and inquiry teaching strategies amongst junior secondary school students in Nasarawa State, Nigeria. The population comprised all the JSII students in public co-educational junior secondary schools in Nasarawa State. A quasi-experimental pre-test, posttest, post-posttest control group design made up of two experimental groups and one control group was used. Three intact JSII classes of three different schools with total of 209 students were used. The subjects were not randomly selected, but the 3 intact classes were randomly assigned to the two experimental and one control groups. The instrument used for data collection was Energy Achievement Test (EAT) which was earlier validated. The reliability coefficient of EAT is 0.87 analyzed using Spearman Brown rank order correlation. Students in the experimental groups were taught energy concepts using sensory stimulation strategy and inquiry strategy respectively, while students in the control group were taught using the

conventional teaching method. Two research questions were formulated with corresponding hypotheses tested at 0.05 level of significance. Data collected were analyzed using mean, standard deviation and ANCOVA statistics. The study revealed that male students had higher mean gains than their female counterparts when taught with the innovative strategies, and sensory stimulation strategy group recorded the highest mean achievement gains for both male and female students. Inquiry strategy group was second in mean achievement gains both for male and female students. In terms of retention however, the female students recorded lower mean retention loss than their male counterparts taught using sensory stimulation strategy. It denotes that female students retained more of the energy concepts than their male counterparts when taught using sensory stimulation strategy. Use of sensory stimulation teaching strategy is strongly recommended to ensure gender equity in learning science and technology based subjects and concepts, among other recommendations.

Keywords: Gender, Energy concepts, Sensory Stimulation strategy, Inquiry strategy, Junior

Secondary School, Students

Introduction

The issue and level of participation of women in science and technology education has become a subject of worldwide concern. Documented research works globally have made interesting revelations on the status of women in science and technology education. The most striking of such revelations as posited by Eniayeju and Tanko (2014) is the dominance of males in science and technology amongst nations of the world except in the USSR. Issues bothering on gender equity, gender stereotype or gender sensitivity and related subjects have become a recurring theme among educators especially in science and technology fields, and then the society at large. Women constitute about fifty per cent of the population in Nigeria. They are capable of making decisive contributions to national development as workers, mothers, initiators and socialization agents when exposed to scientific and technological principles. The low participation of women in science and technology has philosophical, social and economic implications. The increasing research interests in gender factors as they relate to differential performance in learning activities and learners empowerment have been affirmed by Uzoechi and Gimba (2015). In Nigeria's educational system, achievement and retention of concepts by students are function of many interrelated variables such as students' ability, socio-economic status of students' parents, teaching methods, students' attitudes toward subjects of study, school standard, school location, gender, peer influences and motivation.

Gender is seen as all the characteristics of men and women which a particular society has determined and assigned to each sex (Lawani, 2015). It is a culturally or socially accepted way of categorizing subjects into either male or female. Some international conventions have tried to address issues of gender and discriminations based on gender. These international conventions as affirmed by Lawani call for the fair treatment of all human beings, whether female or male. Problem of gender stereotyping permeates the school system. Some subjects and courses are often regarded as masculine, just as some others are regarded as feminine. Gender mainstreaming was among the issues addressed in the development of a revised curriculum, syllabuses, teachers' handbooks, teachers' guides and all other teacher resource materials initiated by National Council on Education (NCE) and handed down to Nigerian Educational Research and Development Council (NERDC) to develop and facilitate the implementation (NERDC, 2012). Gender is important in the educational system. Gender influences curriculum, instructional materials, career choice, general behaviour and activities of students and teachers. In order to eliminate gender stereotyping in schools, according to Lawani (2015), teachers need to accept responsibility for change of behaviour or pattern of lesson delivery and create effective learning environment for all students. Some researchers are of the considered opinion that male students have a higher achievement than female students especially in science, technology,

engineering and mathematics (STEM) education. Others observed that the situation is the opposite. Yet some other researchers found no significant difference between male and female achievement in science and technology related subjects (Uzoechi & Gimba, 2015).

The influence of student's gender in their achievement in Basic Science and Technology has been of concern to education researchers for long. Yet, according to Ugwu and Nzewi (2015), no generally acceptable trend had emerged on the issue. In Nigeria, gender bias is still prevalent in science and technology education spheres. It has persisted even within the classroom and workshop setting. Agu and Edward (2015) pointed out that Nasarawa state is grouped by the Federal government among the less educationally advantaged states in Nigeria especially in terms of female access to and aspiration in science and technology subjects. The influence of gender on science and technology teachers' pedagogical beliefs and ICT classroom practices in secondary schools was investigated by Nwagbo and Ugwuanyi (2015). The outcome showed that gender significantly moderated the pedagogical beliefs of science and technology teachers. Thus it found that male science teachers had higher mean rating than the female science teachers with respect to teachers' pedagogical beliefs. There is no evidence yet on whether comparing effect of use of sensory stimulation and inquiry is gender related. It is therefore, worthwhile to find out if sensory stimulation and inquiry strategies would bridge the gap or otherwise in achievement and retention between male and female students taught energy concepts.

Sensory stimulation refers to a variety of techniques applied to stimulate the senses with a view to increasing alertness and reducing agitation (Gammeltoft, 2005). To Vozzella (2007), sensory stimulation includes visual, auditory, tactile, olfactory, kinesthetic and taste stimulation. The sensory integrative processes help people to interact effectively with the environment. Indeed, the sensory stimulation theory claims that effective learning takes place when the senses are stimulated. Research findings have proven that of the majority of knowledge held by adults, 75% is learned by process of seeing; hearing is next most effective accounting for about 13% while the other senses (smell, taste and touch) account for 12% of what is known (Laird, 1985 in Dunn, 2002).

Inquiry as an innovative teaching strategy is one of the applications of constructivism theory. The process involves students finding out basic concepts via active investigation and use of guiding questions (Jin & Bierma, 2011). Inquiry has to do with 'active learning' technique that emphasizes the understanding of a concept through a process oriented approach and based on previous knowledge. Students use their prior knowledge to build their own enquiries around the previous knowledge built by the teacher. Students work in teams and are guided through questions to consider various procedural steps instead of following instructions in their practical assignment until they realize or uncover trends and patterns in the mechanisms at work. Students have the freedom to be the thinkers

Achievement is the past-oriented way of trying to measure the degree of attainment of success of an individual in an area or activity after adequate training has been carried out (Mangal, 2014).

Achievement addresses the score obtained in posttest using the instruments entitled Energy Achievement Test (EAT) and designated as the posttest mean score. The degree of academic performance of students or the measurable change in behaviour determined by the mean difference between post test scores and the pre-test scores.

Retention is the ability to keep learned experiences for a long time after the learning has taken place, and to continue possession and use or control of something kept in the memory (Cambridge Academic Content Dictionary, 2018). In learning, retention could be described as the ability to recall facts and figures in memory, that is, remembering or the denial of forgetting. It is the mental process of retrieval of information from the past.

Statement of the Problem

Nasarawa is one of the states considered educationally disadvantaged especially in terms of low female access and aspiration in science and technology related subjects at Secondary School and higher institution levels. This low interest rate and poor aspiration to science and technology related subjects by female students may be attributable to the continuous use of conventional teaching methods (for example lecture method). In a situation where appropriate choice is made and the correct teaching method/strategy applied, the female learners and low ability students among the males might be encouraged to pursue career opportunities in science and technology areas and impact of teaching effectiveness will be better felt. Children, both male and female naturally engage in scientific and technological activities long before they enter a classroom. They therefore, need teachers with varied

Ability level refers to students' relative achievement. It is sub-divided and grouped into high ability level and low ability level. Whereas high ability group refers to students who score from 15marks to 40marks (numbering 109) when pretest scores are arranged in descending order, those who score below 15marks (numbering 100) constitute the low ability group. Elekwa, Bamiro, Oluyide, Ladoye, and Olopade (2009) defined energy as the ability of somebody or something to do work. They affirmed that energy can be transformed from one form to another. Work done therefore, becomes energy applied; and work is said to be done when force is applied to move an object through a distance

innovative teaching strategies to harness these creative potentials. Overused traditional teaching method is one directional and tends to limit students' freedom to apply, analyze and synthesize the knowledge being passed across. It makes students passive and discourages meaningful learning which is supposed to encourage teacher-learner and learner-learner interaction, and students' capacities to develop skills themselves. A positive result could be achieved if teachers involve hands-on, minds-on and strategies that appeal to the sense perception of students, engaging students in active learning in consonance with the constructivist education teaching-learning theory. Use of proven innovative teaching strategies can trigger performance driven potentials inherent in students, also inspire female students' interest in Science and Technology related subjects. The problem of this study therefore was to

determine the gender dimension in assimilation of energy concepts among junior secondary school students taught energy concepts using innovative

teaching strategies of sensory stimulation and inquiry.

Purpose of the Study

The main purpose of the study was to investigate gender dimension in assimilation of energy concepts among junior secondary school students taught energy concepts using sensory stimulation and inquiry teaching strategies. Specifically, the study was set to:

1. determine the interaction effect of gender on achievement of students taught energy

concepts using sensory stimulation teaching strategy and inquiry teaching strategy respectively.

2. determine the interaction effect of gender on retention of students taught energy concepts using sensory stimulation strategy and inquiry strategy respectively

Research Questions

The following research questions were posed to guide the investigation:

1. What is the interaction effect of gender on achievement of Students taught energy concepts using sensory stimulation strategy and inquiry strategy respectively?

2. What is the interaction effect of gender on retention of students taught energy concepts using sensory stimulation strategy and inquiry strategy?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

H₀₁: There is no significant interactive effect of gender on the mean achievement scores of students taught energy concepts using sensory stimulation strategy and inquiry teaching strategy.

H₀₂: There is no significant interactive effect of gender on the mean retention scores of students taught energy concepts using sensory stimulation strategy and inquiry teaching strategy.

Research Methodology

The study is a quasi-experimental study. Pre-test, posttest, post-posttest control group design was adopted. There was no randomization of subjects in the study. Three intact classes were randomly assigned to the experimental and control groups respectively. The target population consisted of 21,521 JSII students in public co-educational junior secondary schools in 13 Local Government Areas of Nasarawa State. Accessible population of JSII students comprised 3050 students in 41 public junior secondary schools made up of 1701 male students and 1349 female students. Random sample of 10 schools were selected out of the 41 public junior secondary schools. Intact stream of JSII students was randomly selected from the 10 schools. They were subjected to pre-test. Their mean scores and standard deviations were determined. Three schools and classes with similar mean score and standard deviations were finally selected with a total number of 209 JSII students comprising 100 females and 109 males. ANOVA statistics was used to ensure similarity of the three groups. From the pre-test scores, students of the three groups were classified into

high and low ability levels. An achievement test named Energy Achievement Test (EAT) comprising 40-item multiple choice questions was developed and used for the study. Basic Education Certificate Examinations (BECE) questions based on the concepts of Energy and Principles of Energy-based appliances were adapted. The reliability coefficient of EAT is 0.87 analyzed using Spearman Brown rank order correlation.

The three groups were taught for four weeks. While the two experimental groups were exposed to sensory stimulation teaching strategy and inquiry teaching strategy respectively, the control group was exposed to the conventional teaching method. The posttest was administered as soon as the last class session was over, while the post posttest came up two weeks after the posttest. Research questions were answered using descriptive statistics of mean and standard deviation, while the hypotheses testing were done with Analysis of Covariance (ANCOVA) with the pre-test scores as covariate to control for initial group difference.

Results

Research Question 1

What is the interaction effect of gender on achievement of students taught energy concepts using sensory stimulation strategy and inquiry strategy respectively?

Table 1: Interaction Effect of Gender on Achievement of Students taught Energy Concepts after Treatments have been administered

Gender	Groups	Pretest Mean (\bar{x})	Pretest SD	Posttest Mean (\bar{x})	Posttest S D	N	Mean Gain
Male	Control	14.39	4.706	24.20	3.974	44	9.81
	Sensory stimulation	13.87	3.721	27.63	3.528	30	13.76
	Inquiry teaching	15.31	2.878	25.83	2.802	35	10.52
	Total	14.54	3.934	25.67	3.749	109	
Female	Control	12.75	3.584	22.02	3.527	44	9.27
	Sensory stimulation	14.33	3.211	27.22	3.344	27	12.89
	Inquiry teaching	15.62	2.783	24.62	2.665	29	9
	Total	14.01	3.460	24.18	3.873	100	
Total	Control	13.57	4.239	23.11	3.894	88	9.54
	Sensory stimulation	14.09	3.466	27.44	3.417	57	13.35
	Inquiry teaching	15.45	2.817	25.28	2.786	64	9.83
	Total	14.29	3.715	24.96	3.872	209	

Table 1 shows the mean scores, the standard deviations and the mean gain scores of gender on achievement for the groups. For the various teaching strategies, the male had higher mean gain score. Males taught using the sensory stimulation strategy had the highest mean gain of 13.76 as against their female counterparts taught using sensory stimulation who had 12.89. Male students taught using inquiry teaching strategy followed male students of sensory stimulations with a mean gain of 10.52 as against their female counterparts who had mean gain of 9. Male and female students had highest mean gain when

taught using sensory stimulation than inquiry and conventional method. The standard deviation was higher for posttest with 3.344 while pre-test had 3.211 for female students taught using sensory stimulation. The standard deviations are proportionately lower for posttest than pre-test for female students taught using inquiry teaching strategy and conventional teaching method. For the male students, the standard deviations are proportionately lower for posttest than the pre-test using different experimental groups.

Research Question 2:

What is the interaction effect of gender on retention of Students taught energy concepts using sensory stimulation strategy and inquiry strategy?

Table 2: Interaction Effect of Gender on Retention of Students taught Energy concepts after Administering Treatments

Gender	Groups	Posttest Mean (\bar{x})	Posttest SD	Retention Mean (\bar{x})	Retention S D	N	Mean Loss diff.
Male	Control	24.20	3.974	21.11	3.578	44	3.09
	Sensory stimulation	27.63	3.528	25.70	3.825	30	1.93
	Inquiry teaching	25.83	2.802	23.86	2.625	35	1.97
	Total	25.67	3.749	23.26	3.852	109	
Female	Control	22.02	3.527	19.59	3.075	44	2.43
	Sensory stimulation	27.22	3.344	25.63	3.410	27	1.59
	Inquiry teaching	24.62	2.665	22.76	2.149	29	1.86
	Total	24.18	3.873	22.14	3.846	100	
Total	Control	23.11	3.894	20.35	3.404	88	2.76
	Sensory stimulation	27.44	3.417	25.67	3.602	57	1.77
	Inquiry teaching	25.28	2.786	23.36	2.465	64	1.92
	Total	24.96	3.872	22.72	3.880	209	

Table 2 shows the posttest and retention mean scores, standard deviations and mean loss difference for gender and groups. The study showed that the mean interaction effect of male students and control has the highest mean loss difference of 3.09; male students and sensory stimulation strategy had the lowest mean loss difference of 1.93 and closely followed by male students and inquiry teaching strategy which had mean loss difference of 1.97.

The interaction effect of female students on treatment shows that female students and control

group had the highest mean loss of 2.43; female students and sensory stimulation strategy had the least mean loss of 1.59 and closely followed by female students and inquiry teaching strategy with a mean loss of 1.86. The retention standard deviation was relatively lower than the posttest standard deviation for both male and female control and inquiry groups. But the retention standard deviation was higher than the posttest standard deviation for male and female treatment groups taught using sensory stimulation teaching strategy as can be seen from table 2.

Hypotheses

H₀₁: There is no significant interactive effect of gender on the mean achievement gain scores of students taught energy concepts with sensory stimulation strategy and inquiry teaching strategies.

Table 3: ANCOVA Test on Effect of Gender on Achievement in Energy Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	811.793 ^a	3	270.598	24.047	.000	.260
Intercept	4112.579	1	4112.579	365.472	.000	.641
Pretest Scores	681.144	1	681.144	60.531	.000	.228
Gender	104.251	1	104.251	9.264	.003	.043
Gender * Pretest Scores	68.002	1	68.002	6.043	.015	.029
Error	2306.819	205	11.253			
Total	133294.000	209				
Corrected Total	3118.612	208				

a. R Squared = .260 (Adjusted R Squared = .249)

Table 3 reveals that there was a significant interaction effect of gender on the posttest scores of students [$F(1, 205) = 6.04$, $P < 0.05$, Partial $\eta^2 = .029$, $R^2 = .00084$]. The implication of this is that since p-value (.000) of the F-ratio was significant, therefore, the null hypothesis of interaction effect of gender on the mean posttest scores was

rejected. The R Squared shows that the independent variables accounted for only .08% of the variation of gender on posttest of students taught energy concepts using the innovative strategies. The estimated partial Eta squared indicates that the treatments accounted for 2.9% of the variance observed in the posttest score.

Table 4: Comparisons of Gender Groups on Students Achievement in Energy concepts

(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig. ^a	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
Male	Female	1.223 [*]	.466	.009	.305	2.141
Female	Male	-1.223 [*]	.466	.009	-2.141	-.305

Centred on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 4 shows the post-hoc test between gender and groups, where the difference between the treatments groups lie after the posttest in Energy concepts. The result reveals that there is a

significant interaction effect of gender on mean achievement of students ($p = .009$; $p < .05$) taught energy concepts.

Ho₂: There is no significant interactive effect of gender on the mean retention scores of students taught Energy Concepts with sensory stimulation strategy and inquiry teaching strategy.

Table 5: ANCOVA Test on Effects of Gender and Mean Retention Scores of Students in Energy Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	673.985 ^a	3	224.662	18.738	.000	.215
Intercept	3317.430	1	3317.430	276.687	.000	.574
Gender	60.391	1	60.391	5.037	.026	.024
Posttest Scores	603.885	1	603.885	50.366	.000	.197
Gender * Posttest Scores	40.899	1	40.899	3.411	.066	.016
Error	2457.919	205	11.990			
Total	111041.000	209				
Corrected Total	3131.904	208				

a. R Squared = .215 (Adjusted R Squared = .204)

Table 5 shows that there was no significant interaction effect of gender and treatments on the retention score of student [$F(1, 205) = 3.41$, $P > 0.05$, Partial $\eta^2 = .016$ $R^2 = .00025$]. The implication of this is that since p-value (.000) of the F-ratio was not significant, the null hypothesis on the interaction effect of gender and retention scores was accepted. The R

Squared shows that the independent variables accounted for only .02% of the variation in the interaction effect of gender on retention of students' in energy concepts. The estimated partial Eta squared indicates that gender and mean retention score accounted for 1.6% of the variance observed in the post-posttest.

Discussion of Results

Result of the analysis in Table 1, 3 and 4 showed that both male and female students had highest mean achievement gains and best impact when taught Energy concepts using Sensory stimulation strategy, and closely followed by both male and female students taught energy concepts using inquiry teaching. Achievement was lowest for both male and female taught using the conventional teaching method. For the mean interaction effect of gender, male students have higher mean achievement gains than their female counterparts when different treatment groups are considered. Male students taught with sensory stimulation strategy had the highest mean gain.

Result of the analysis in Table 2 and 5 revealed that mean retention loss was least for both male and female students taught energy concepts using sensory stimulation strategy, followed by group taught using inquiry strategy. Control group had the highest mean retention loss for both male and female students. However, the result showed that female students have better retention capacity than their male counterparts for those taught energy concepts using the innovative strategies. The least mean retention loss was for female students taught using sensory stimulation and

followed by mean retention loss of female students taught using inquiry strategy.

The finding here is in disagreement with the findings of Ogbu, Musa, Kurumeh and Tyoor (2018) who investigated achievement, retention and gender effects on upper Basic Eight students in number and numeration using competitive learning strategy where the female students had better mean achievement than their male counterpart, but in agreement that the retention capacity of the female students is better when

compared with their male counterparts. The finding is in tandem with the findings of Owodunni and Ogundola (2013) who reported higher mean score for boys than girls taught Electronic Works trade using reflective inquiry instructional technique, and girls having better mean retention score than boys. The finding is in contradiction with the findings of Aniodoh and Egbo (2013) who established that the female students did better than their male counterparts when taught Chemistry using inquiry role instructional model.

Conclusion

Based on the findings of this study, the following conclusions are made:

1. Gender has influence on students' achievement and retention when taught energy concepts using sensory stimulation strategy and inquiry strategy respectively.
2. Male students achieved better than female students when taught using sensory

stimulation and inquiry strategy, with the highest achievement recorded in students taught using sensory stimulation strategy.

3. Female students had more retention than their male counterparts when taught with sensory stimulation strategy.

Recommendation

Based on the findings of this study, the following recommendations are hereby made:

1. Teachers should employ varying teaching strategies other than the conventional teaching methods in order to enhance students' achievement and retention.
2. Innovative teaching strategy such as sensory stimulation strategy should be employed in teaching science and technology so as to enhance female students' interest and aspiration in the study of science and technology programmes.

3. Curriculum planners, Writers/ book publishers and policy makers in the Universal Basic Education programme should include sensory stimulation strategy as one of the innovative teaching strategy when planning for the teaching and learning of Science and technology related concepts/subjects.

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