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A Study in Mathemagenic Activities: Gender Differences in Understanding Chemistry. Implications for Women Education

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Abstract
The effect of mathemagenic activities on gender groupings in learning and understanding Chemistry concepts was investigated. Three hundred and sixty (360) Senior Secondary two Chemistry Students from four co-educational institutions in Ondo North Local Government Areas of Ondo State constituted the sample. The study adopted the quasi-experimental design of the pre-test and post-test control group. Data collected were analysis using Means, Standard Deviation, and Analysis of Covariance (ANCOVA) at 0.5 level of significance. The results showed that male and female students in the experimental groups performed better than those in the control group. It was revealed that this approach does not discriminate among sexes in their effectiveness in students' learning tasks. Finding in this study have shown that the given treatments have no bias against gender. In order words, the three treatment cues proved equally effective for both male and female students. The results of the study tend to suggest that Chemistry teachers can adopt this treatment in their classes and de-emphasize gender consideration in the learning of chemistry concepts.
Key Words: Mathemagenic Activities and Gender Differences in Chemistry

1.0 Introduction

Many women and girls in developing countries are still not educated as reported by the Department for International Development (Piwuna, 2001 and DFID, 2007). Women in this type of environment are unable to secure their future and contribute to the economy. The Federal Government of Nigeria National Policy of Education (1981) revised (2004) recognized the fact that the right to education is a fundamental right of all individuals regardless of age and sex (gender). Gender bias in the classroom is a complex phenomenon that continues to reside in the educational practice. In an attempt to bring this problem into focus, the national population census of 1991 in Nigeria put men population at about 50,320,000 representing 50.32% while that of women was 49,680,000 representing 49.68% of the total population. With this statistics, Ibrahim (2001) was of the opinion that woman constitute almost 50% Nigeria population. Ciroma (2007) affirms that the government of Nigeria is committed to build a nation devoid of gender discrimination, guaranteeing equal access to political, social and economic wealth, creating opportunities for women and men develop a cultural that places premium on the protection of all, including children. As laudable as this objectives is, it was observed that Nigeria fell short of the desired result of given males and females equals opportunities to advance socially, physically, education, politically and economically.

1.1 Literature Review

Mura (1995) asserts that boys and girls have different ways of learning and that are better taught separately while Fennema (1996) reveals that in a co-educational classroom setting, boys received more attention than the girls. However, Heller and Persons (1981) had earlier deputed this difference by finding no difference in the feedback given to boys and girls. Although, boys and girls differ in their physical, emotional and intellectual development, efforts to link gender difference in science with intellectual capabilities have however proved untenable (Inyang and Hannal, 2000 and Orimogunje, 2006). Social and cultural factors are the major reasons leading to gender difference in academy performance. These factors includes student's familiarities with the subject, changes in career aspiration, gender perceptions of specific subject, and presentational styles of boys and girls (Streitmatter, 1994 and Gallagher, 2001).

The issue of gender is an important factor in science education especially with increasing emphasis on way to boost manpower for technological development as well as increasing the population of females in science and technology fields. However, research findings have been inconclusive as to who achieves higher, male or female. It has been reported that female have markedly improved their educational performance (Omoniyi, 2008 and Fasola 2009). Therefore, this study is interested in finding out what influence (if any) gender would have when students are exposed to practical lesson in Chemistry through the use of mathemagenic activities as pedagogical aid. The study of 'mathemagenic' falls within the general interest area of how people learn from ordinary written instruction (verbal learning). The term itself was coined by Rothkopf (1970) from two Greek words- 'Mathemain'-meaning what is learnt and 'gignesthai'- to be born. Mathemagenic activities describe some external activities which serve to activate and facilitate the internal processes of learning. These activities include the use of advance organizers, post-organizers, adjunct questions and instructional objectives in texts. Anaso and Anaso(2000), in their study, reported that the results of teaching classes using guided discovery method showed mutually that the boys' school performed better than the girls' school and that even in co-educational schools, boys generally better than girls. The study by the American Association of University Women, Gender Gaps! Reported that:

- even though similar number of high school boys and girls are taking mathematics and science classes, boys are still far outnumber girls in Chemistry
- in school-to-work programs, which combined challenging academics with vocational training, girls still tend to cluster in traditional female occupations.
- although girls are taking more advanced placement courses and getting better grades, their scores on those examinations still tend to be lower than boys' scores.
- on large-scale examination such as the National Assessment of Educational Progress (NAEP), the top scores in science still tend to be boys.
- When examine language arts scores, gender gaps exist on State, National and International bases with girls consistently outperforming boys. (Viadero, 1998)

Adigwe (1992) also investigated sex differences in chemical problem solving achievement of Nigeria secondary school Chemistry students. The study used 100 males and 100 females who were exposed to chemistry achievement test after they had been taught using problem strategy. The result indicated significant differences in achievement in favour of males in all the skills investigated. Amara (1987) discussed the state of girls in science education in Sierra-Leone and suggested that a science curriculum based on indigenous technology may be more appropriate to their needs than the current westernized syllabus. Inyang and Hannah (2000) investigated the influence of ability and gender grouping on senior secondary Chemistry students' achievement on the concept of redox reaction. One hundred and sixty senior secondary II chemistry students from two co-educational institutions in Itu Local Government Area of Akwa Ibom State constituted the experimented and the control classes. A t-test analysis revealed a significant different between the means post-test and pre-post scores in Achievement Test on Redox-reaction by each of the ability levels. On the basis of gender, there was no significant difference in the achievement of the students in the post-test Scores. This is in consonance with Shaw and Doan (1990) who pointed out that students did not exhibit any gender difference in achievement and attributes towards science. Therefore, this study is interested in finding out what influence (if any) would gender have when students were exposed to practical lesson in Chemistry through the use of mathemagenic activities as pedagogical aid.

1.2 Research Question:

What is the impact of gender on Chemistry students when exposed to the use of mathemagenic activities?

1.3 Hypothesis:

There is no significant difference in the academic performance of male and female Chemistry students who used instructional objectives, adjunct question, combined mode as instructional strategies in the learning volumetric analysis.

2.0 Methodology

This study adopted the pre-test and post-test control quasi- experiment design. The population for the study comprised all the Chemistry students in the all secondary schools in Ondo North Senatorial District of Ondo State in Nigeria. Three hundred and sixty senior secondary class II Chemistry students constituted the sample. Purposive sampling technique was used to select the sample schools based on some criteria such as, school with well-equipped library, well-stocked with Chemistry Laboratory and professionally qualified and experienced Chemistry teachers. The chemistry achievement texts (pre-test and post-test) were made up of 35 items based on both cognitive and verbal domain of the learning materials. This instrument was given to test expert who critically assessed it for content validity and ensured that all the test items were related to the content in the textual materials under study. The reliability of the instrument was tested using Kuder Richardson formula (K_{20}) and a reliability coefficient of 0.83 was obtained. The recommended learning materials were sent to WAEC/SSCE/NECO examiners to examine the instructional objectives and adjunct questions in text raised and determine their suitability in relation to the contents to be learned in the classroom setting.

3.0 Results and Discussion

3.1 Question:

What is the comparative effect of the three experimental treatments among the male and female Chemistry in the learning volumetric analysis?

In order to answer the question, the post-test scores of the students for each experimental group were compared among the boys and girls. These scores were presented in table 1

Table 1: Post-test Mean Scores and Standard Deviation of the Three Experimental Control Groups According to Gender Groupings.

Group	Gender	N	Post-test mean	SD
Texts +IOs	M	56	15.79	4.36
	F	34	17.82	3.76
Texts+AQs	M	51	18.37	4.22
	F	39	17.56	4.67
Texts+IOs +AQ	M	42	19.64	4.20
	F	48	19.46	3.93
Control	M	50	9.30	2.47
	F	40	9.63	3.26

Table 1 show that the post-test mean scores for the male groups in the three experimental groups control group were 15.79, 18.37, 19.64 and 9.30 while those for female groups were 17.82, 17.5, 19.46 and 9.63 respectively. Both boys and girls in the experimental groups performed better than those students in the control group at the post-test stage through the use of mathemagenic activities. However, both boys and girls in group three (Texts +IOs +AQs treatment) had the highest mean scores (19.64 for boys and 19.46 for girls). It is therefore observed that the combined modes of instruction inspired the highest performance for both boys and girls. This apparently showed that the treatment was highly effective to have reduced student's learning difficulty in volumetric analysis.

3.2 Hypothesis:

There is no significant difference in the academic performance of male and female Chemistry students who use instructional objectives, adjunct questions and combined mode as instructional strategies in the learning of volumetric analysis.

In testing this hypothesis, the post test scores for the three experimental and the control groups of academic performance of subjects with respect to male and female were subjected to Analysis of Covariance (ANCOVA). The pretest scores were used as covariates. The results of the ANCOVA on the scores were presented bellow.

Table II : ANCOVA Showing the Academic Performance of Male and Female Students in both Experimental and Control Groups.

Source	SS	Df	MSS	F_{cal}	F_{table}
Covariate (Pre-CAT)	650.460	1	650.460	48.269	3.84
Group	5693.908	3	1897.969	140.843	2.60*
Gender	.128	1	.128	.010	3.84
GRP*Gender	88.784	3	29.595	2.196	2.60
Error	4729.985	351	13.476		
Corrected total	11014.331	359			
Total	101613.000	360			

*P>0.05

The table 11 showed that the F-table of 2.196 (df=3:360) yielded no significant difference in the academic performance of both male and female students in chemistry achievement test. The main effect of gender (f=.010; p>0.05) is not significant. The group by gender interaction is not significant either. Since, the F_{cal} (2.196) is less than the F_{table} (2.60) at 0.05 levels of significance. Hence, the Null hypothesis was accepted. This suggests that this approach does not discriminate among sexes in its effectiveness in CAT.

3.3 Discussion.

The gender analysis of performance among the three modes of instructions indicated that the male and female students in the experimental groups performed better than those in the control group. This justified that mathemagenic activity as a better mode of instruction in learning some difficult concepts in Chemistry.

It was also observed that the academic performance of male and female students in both experiment and control groups was upheld. This means that this approach does not discriminate among sexes in their effectiveness. In the area of sex difference in performance, the study revealed that gender does not have a significant difference in students' achievement in the learning of volumetric concept in chemistry when exposed to mathemagenic activities. The result agrees with the findings of Okebukola (1985), Alebiosu (1998), and Iyang and Hannal (2000) who reported that achievement in science is not gender sensitive and that achievement only depended on the student's personal efforts rather than sex role variables. However, the results is contrary to the finding of Anaso and Anaso (2000) and Omoniyi (2003) who concluded that boys were found to do better than girls when both groups are exposed to the same set of science instructions

From the result of this study, it was revealed that gender issue and students' study activities do not interact significantly to influence students' performance towards the learning of volumetric analysis in Chemistry. This result could be so, because sex may not be a determining factor in studying and passing practical test in Chemistry. This result supports the findings of Gbore (2006) and Adeyemo (2005) who argued that the interaction of sex and study behaviour does not produce any significant effect on the academic performance of male and female students.

3.5 Implications

Based on the findings of this study, the following implications were immerges:-

1. Results from the findings of this study shown that sex as a variable indicated no hindrance to student's academic performance in learning Chemistry when exposed to mathemagenic activities, therefore, teachers should de-emphasize gender consideration in the teaching of Chemistry concepts.
2. The use of the mathemagenic activities in the teaching and understanding Chemical concepts should receive great emphasis in schools. This method calls for patience, experience and expertise on the part of the teacher. This implies that teachers (male and female) should be constantly trained and retrained at all levels of educational structure on the use of this pedagogical aid.
3. Principals, Head-teachers, School inspectors and Parent Teachers' Association should cooperate, support and encourage the practicing Chemistry teachers in the area of providing consumable teaching materials and apparatus for effective laboratory activities.
4. Authors should pay attention to learners' learning materials that are not only relevant, but also instructionally useful for the attainment of the overall objectives.
5. Educators should make use of instructional objectives and adjunct questions for evaluation of Chemistry textbooks to be recommended for students use.

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