EFFECTS OF CLASS-SIZE AND GENDER ON ACADEMIC PERFORMANCE OFSECONDARY SCHOOL CHEMISTRY STUDENTS IN KADUNA STATE, NIGERIA

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Abstract

This study investigated effects of Class-size and Gender on the Academic Performance of Secondary School Chemistry Students in Kaduna State, Nigeria. Quasi-experimental research design was adopted for the study. The target population was all Senior Secondary School II students offering Chemistry in Zaria Education Zone, Kaduna State, Nigeria. There were twelve secondary schools in the Zone with a total number of 2,327 students. The sample for this study was a total number of One Hundred and Fifty (150) students drawn randomly from three secondary schools in the Zone. One research question and one null hypothesis were formulated to guide the study. The instrument used for data collection was Chemistry Achievement Test (CAT). A pilot testing of the Chemistry Achievement Test (CAT) was conducted using 50 SS II students offering Chemistry Government secondary schools not part of the study area. The data obtained through CAT were subjected to statistical analysis to test the hypothesis at $P \leq 0.05$ significant level. The statistical tool used in testing the Hypothesis was One-way analysis of variance (ANOVA). The results obtained showed a significant difference between the mean scores of male subjects in the three class-size groupings (F-value cal is = 4.27, while F-value crit = 3.10 with df = 89). The findings resulting from this study suggest that small class-size grouping favored male students in chemistry learning. Results obtained also showed a significant difference between the post-test mean scores of female subjects in the three class-size groupings (F-value cal = 10.14 while F-value crit is 3.15 with df = 59 at α = 0.000). Female subjects in small class-size achieved significantly better than those in medium and large class-sizes. It was recommended that the makers of the National Policy on Education (FME 2014) need to review class sizes and students-teacher ratio requirements since the recommended class-size of 40:1 appears to be too large for students in understanding chemistry concepts.

Key words: Class-size, Academic Performance, Chemistry students.

Introduction

Class-size is identified as a course/section combination with one or more teachers scheduled in a particular room, in a particular school, in a specific term during a specific period and day of the week. Class-size is determined by bringing the total number of students in the classroom and dividing by the number of teachers assigned to the students (FSIR 2003-04). Class-size according to Teachmint (2024) is the total number of students in each classroom. Teachmint is

of the view that depending on the class-size, teachers may divide the students by making an active learning classroom where the teacher engages the learners in deep learning. He noted that

active learning strategies promote a more distinguished order of thinking. Generally, as per the class-size, teachers usually divide the students into a mixed group, this means that the weak students, average learners and the best learners are all in a mixed class. The essence of the mixed class is for the best learners to motivate the weak and average students to be active.

The term "gender", on the other hand, refers to the amount of muscularity and femininity in an individual construct and its roles change in response to changing values, attitudes, opinions and circumstances. Gender is therefore a wider perspective with women being only a category of focus. Gender, according to Nnoli (2015), is a socially or cultural constructed characteristic and roles which are associated with males and females in a society. Aransi (2017) is of the view that gender (male and female) is a range of physical, biological, mental and behavioral characteristics pertaining to and differentiating the feminine and masculine population.

Chemistry, as one of the variables in this study, is defined by Anaso (2017) as the branch of science that deals with the behavior of matter in relation to their composition and the various changes they undergo when combined with other elements. Nnoli (2011) specified that chemistry is the science that systematically studies compositions, properties and activities of organic and inorganic substances, and various elementary forms of matter.

Academic Performance essentially applies to what an individual can do within a specific criterion domain. It is assessed by outcomes and improvement in the performance resulting from education. Performance is what students are able to gain in the Senior School Certificate Examination (SSCE) after completion of the Senior Secondary Instruction. The concept of academic Performance is considered to be the level of individual's educational attainment as determined by comparing his average score with others of the same age or peer group.

There is the concern in science education (chemistry in particular) that girls are not achieving as much as their male counterparts. Some people agreed and are of the view that boys perform better in science than girls. Omosor, Ajaja & Kpangban (2024), noted that learning with process-oriented guided inquiry learning enhanced students' achievement and it also favored both male and female students indicating it is gender friendly. Barthlow and Watson (2014) also reported that the performance in the posttest of both male and female learners were equally rated in achievement in their study on the effectiveness of Process Oriented Guided Inquiry learning to reduce alternative conceptions in Secondary chemistry. Jibrin, Mohammad and Abdulhamid (2015) discovered significant difference in the academic achievement of male and female NCE students taught genetics using problem-solving instructional strategy in favor of the males. Female science students appreciate the role of science as much as their male counterparts but lag behind in knowledge, application and communication in science.

Igabai (2023) revealed that there is no significant difference between male and female performance in school examinations. This finding is contrary to the view of Aransi (2017), whose study on effect of class classification, class size and gender on academic performance, shows that there is gender gap in English language in favor of female students. This is also in line with Ashetu (2015) who stated that gender gap in Mathematics, English and Aptitude test

was in favor of male students. Ariz and Farah (2017) in their study on teaming styles, gender and academic performance on post graduate management student, reported mixed outcome in which the male students performed better in finance and marketing disciplines while females performed higher in human resources and international business disciplines. Their findings are in conformity with the study conducted by Aransi (2017) that gender and class size has insignificant influence on academic performance of students in Mathematics and English language. These studies also aimed to explain the disparity between and decline in the number of girls voluntarily choosing to study in the science fields. Gender stereotyping is also found to play a part in this disparity as most often, the field of science is largely assigned as a male domain thus, posing as a major cause of low female participation in the sciences.

Development of sex differences as seen from the foregoing discussion is intricately facilitated and interwoven with the gradual process of socialization in many families, peer groups and age grades, religious institutions, school and mass media. Thus sex difference connotes the acquisition of distinct sex roles for boys and girls.

The different literatures cited have shown some sex differences with respect to performance. The differences have consistently favored the male group, however, the causes of these differences is not well understood. Studies from the foregoing have centered on differences in numerical and spatial relation test, restructuring of stimuli elements and differing attitude towards chemistry however, the explanation for the observed differences in gender in chemistry is inconclusive.

In this study, research was conducted to find out if performance in chemistry is gender stereotyped using the various class-sizes and also to identify any significant difference(s) in the academic performance of male or female students in large, average (medium) and small class-sizes.

Statement of the Research Problem

The problem of this study was the investigation of the Effects of Class-size and Gender on the Academic Performance of Chemistry Students in Kaduna State Nigeria. Gender issues in science and in chemistry education in particular, have been the concern of many educators and series of research have been on-going in this area, Ariz and Farah (2017).They further reported mixed outcome in which the male students performed better in finance and marketing disciplines while females performed higher than their male counterparts in human resources and international business disciplines. They stated that this phenomenon is rather cultural than genetic. In problem solving, Jibrin, Mohammed and Abdulhamid (2015) found differences in performance and they reported significant gender disparities in performance and Performance in science and science related tasks which favored the males.

From the literature reviewed, the researcher observed that the issue of gender has persisted for a long time. The explanation for the observed disparity in sex difference in chemistry, as a subject, is inconclusive. It is therefore necessary to investigate further into gender stereotyping and class size as it affects academic performance of chemistry students at the secondary school level

Objectives of the study

The objective of this study was to determine if class-size has any significant effect on the academic performance of male and female students in large, medium and small class-sizes.

Research Question

One research question was raised to guide the study.

a. What is the effect of class-size on the academic performance of male and female students in large, medium and small class-sizes?

Research Hypothesis

One hypothesis was formulated and tested at 0.05 level of significance in the study.

Ho_1: There is no significant difference on the academic performance of male and female students in large, average (medium) and small class-sizes.

Methodology

Quasi-experimental research design was adopted to investigate effect of different class-sizes on the academic performance and gender of students in Chemistry. The design consisted of three equivalent groups; one group of twenty – five (25), one group of fifty (50) students and another group of seventy five (75) students. In this study, the target population was all Senior Secondary School II chemistry students in Zaria Education Zone, Kaduna State, Nigeria. There were twelve Secondary Schools in the Zone with a total number of 2,327 chemistry students. The population of the study had many features in common, among them was that the schools had, in the past, presented students for Senior School Certificate Examinations (SSCE).

A total sum of One hundred and fifty (150) senior secondary school (SSS) II students offering Chemistry was the sample used in this study were randomly selected from three secondary schools in Zaria, Kaduna State. The three secondary schools were randomly selected with respect to a co-educational criteria, that is, all three schools were co-educational comprising of boys and girls and this enabled the researcher determine the gender effect on the understanding of the chemistry concepts being taught. In each of the three schools, one formed the small class-size, the second formed the average class-size and the third school formed the large class-size. This division into various class-sizes of 25, 50 and 75 was done by stratified random sampling technique.

Table 1 gives the distribution of schools and the number of students used in the study.

Table 1: Details of Samples of the Study

S/No	Name of schools	Grouping	Size	Sample size by sex		
				Male	Female	Total
1	Secondary School 1	Experimental group 1	25	15	10	25
2.	Secondary School 2	Experimental group 2	50	30	20	50
3.	Secondary School 3	Experimental group 3	75	45	30	75
			150	90	60	150

The instrument used for this study was Chemistry Achievement Test (CAT) developed by the researcher. The Chemistry Achievement Test consisted of thirty multiple choice questions to find out the extent the students understood the selected Chemistry concepts. The Chemistry Achievement Test were selected from a collection of some relevant SSCE past questions and were validated by a panel of experts including two Chemistry Senior Lecturers at a university, one science educator and two secondary school chemistry teachers. Each of the thirty (30) multiple choice items consisted of four response options. The test items reflected the four (4) cognitive levels based on Bloom's (1986) Taxonomy for the cognitive domain. The multiple choice items CAT were used at two different occasions, first, as a pre-test to determine the strength and equality of the samples at the start of the study and secondly as a post-test in order to determine or assess the performance of the students after the treatment. A pilot testing was conducted using the Chemistry Achievement Test (CAT) on 50 SSS II Chemistry students of a Government Secondary School separate from those in the study sample.

The content validation of the Chemistry Achievement Test (CAT) was carried out by a panel consisting of five experts in Chemistry education before administration. The test instrument containing 30 multiple choice items was given to all the students taking part in the study (that is, the three comparable groups) and the data obtained were subjected to statistical analysis to test the hypothesis at P≤0.05 significant level. The statistical tool used in testing the Hypothesis was the one-way analysis of variance (ANOVA) and the data obtained was analyzed using Statistical Packages for Social Sciences (SPSS) Version 11.50. .

Results

Three types of data were collected in this study and they are classified as follows:

(a) Experimental Group 1 contained 25 subjects
(b) Experimental Group 2 contained 50 subjects
(c) Experimental Group 3 contained 75 subjects

The data obtained were:

1. Performance scores from the pre-test (Table 2 below)
2. Performance scores from the post -test (Tables 3 – 7 below).

The pre-test scores were used to establish the equivalence of the three comparable groups (School EG1, EG2, and EG3) before the Treatment. The pre-test scores were subjected to a one-way analysis of variance and tested at a significant level of 0.05 as shown in Table 2.

Table 2: One-way Analysis of Variance of the Pre-test Mean Scores of Subjects in the Three Classes

Source of variance	Sum of squares	Df	Mean squares	Fcal	P	Remark
Between groups	14.43	2	7.21	1.71	0.18	NS
Within groups	617.95	147	4.20			
Total	632.37	149				

* Not significant at P≤ 0.05

The obtained F-value (calculated) is 1.71. This value is less than the F- value critical which is 3.05 at $\alpha = 0.05$ with df = 149. The result shows that there is no statistically significant difference between the Performance s of subjects in all the classes/groups. The P-value of 0.183 is also not significant thus implying group equivalence with respect to their knowledge of Chemistry concepts before the exposure to treatment since the level of significance is 0.05.

Ho[1]: There is no significant difference on the academic performance of male and female students in large, medium and small class-sizes.

To test this hypothesis, the post-test performance scores of the subjects were split according to gender of the subjects in the groups/classes. The mean scores of the male subjects from the three groups were subjected to one way analysis of variance. The same procedure was undertaken for the female subjects in the three groups/classes. The results are presented in Tables 3 – 6.

Table 3: One-way analysis of variance of male subjects Post-test scores in the three Classes/Groups

Source of variance	Sum of squares	Df	Mean square	Fcal	P-value	Fcrit	Remarks
Between groups	165.178	2	82.589	4.27	0.017	3.101	S
Within groups	1679.94	87	18.310				
Total	1845.122	89					

* Significant at P≤ 0.05

The result from Table 3 revealed that the scores obtained are F-value calculated is = 4.27, while F-value critical is = 3.10 with degree of freedom = 89, P-value of 0.01 at $\alpha = 0.05$ was obtained for male subjects in the three classes.

The result indicates a significant difference in the mean scores of male subjects in the three classes following the results obtained from the comparison of the male subjects in the three groups in Table 4, further shows that the male subjects in small class-size achieved significantly higher than those subjects in medium and large class-sizes with mean score of 14.27. The least score of 10.23 was obtained by male subjects in the medium class.

Table 4: Comparison of post-test mean scores of male subjects in small, medium and large class-size using statistical tool of one way analysis of variance

Groups	Count	Sum	Average
Small (Group E_1)	15	214	14.27
Medium (Group E_2)	30	307	10.23
Large (Group E_3)	45	536	11.91

The result in Table 4 shows that there is significant difference in performance of the male subjects in the three groups, as small class-size was shown to be more favorable to the male subjects who achieved a better score. The essence of the result in table 4 is to show which group achieved highest/best in performance.

To assess the performance of female subjects in the three classes, one way analysis of variance was used and the result is presented in table 5.

Table 5: Analysis of variance of female Post Test Scores to show Performance of the three classes

Source of variance	Sum of Square	Df	Mean Square	Fcal	Fcrit	P-value	Remarks
Between groups	234.43	2	117.217				
				10.15	3.15	0.000	Sig.
Within Groups	658.417	57	11.551				
Total	892.850	59					

* Significant at P≤ 0.05

Results from Table 5 show that F-value calculated is = 10.14 while F-value critical is 3.15 with df = 59 at α = 0.000. The result reveals that there is a significant difference in the mean scores of female subjects in the three classes.

Table 6further gives a more detailed result as to which group in particular achieved the highest amongst the three classes.

Table 6: Summary of one way analysis of variance showing performance of female subjects in the 3 classes using their post test scores

Groups	Count	Sum	Average
Small (Group E_1)	10	138	13.8
Medium (Group E_2)	20	181	9.05
Large (Group E_3)	30	248	8.27

The result from Table 6 indicates that the female subjects in E_1 achieved the best with mean score of 13.8, followed by E_2 with mean score of 9.05 and E_3 with mean score of 8.27 achieved the least.

Analysis from the results (Table 3 to 6 above), suggest that subjects from small class (E_1) achieved the highest scores. It follows that the use of small class-size (E_1) facilitates learning hence better performance among chemistry students. The null hypothesis is therefore rejected since a significant difference exists and the performance rate increased for both male and female subjects as class-size decreased from large to small class-size.

Discussion of the Findings

The results from testing this hypothesis show a significant difference between the mean scores of male subjects in the three class-size groupings (See Table 3). The summary of performance of male subjects in class grouping of 25 with average mean score of 14.27 achieved higher than their counterparts in class-size grouping of 50 and 75 with mean scores of 10.23, 11.91 respectively (see Table 4). The findings resulting from this study suggests that small class-size grouping favored male students in chemistry learning.

Results from testing Ho1 also showed significant difference between the post-test mean scores of female subjects in the three class-size groupings when taught chemistry concepts (see Table

5). Female subjects from small class-size achieved better (mean score of 13.8) than those in medium and large class-sizes (mean scores of 9.05 and 8.27 respectively) as seen in Table 6. High academic performance rate observed from small class-size comprising of both male and female subjects from this study suggests that when small class-size is employed in the teaching of chemistry more students may enroll. Thus, the research questions "does class-size have any significant difference on the academic performance of male and female students in large, medium and small class-sizes?" is answered by this finding. The findings from this study are consistent with that of Ashetu (2015) who stated that gender gap in Mathematics, English and Aptitude test was in favor of male students. This is however contrary to the result of Igabai (2023) who revealed no significant difference between male and female performance in school examinations. This finding is also contrary to the reports of Ariz and Farah (2017) whose study on teaming styles, gender and academic performance on post graduate management students, reported mixed outcome in which the male students performed better in finance and marketing disciplines while females performed higher in human resources and international business disciplines. Their findings are in conformity with the study conducted by Aransi (2017) that gender and class size has insignificant influence on academic performance of students in Mathematics and English language.

Conclusion

Empirical findings from this study indicate that, students (male and female) in small class-sizes achieved significantly higher than students in medium and large class-sizes. Thus far, it appears that more studies are needed in this area to establish the appropriate class-sizes that would enhance academic performance in chemistry.

Recommendations

The following recommendations were made on the basis of the findings and conclusions emanating from this study.

1. The programmes developers of the National Policy on Education (FME 2004) should review class size and students-teacher ratio requirement since the recommended class-size of 40:1 appears to be too large for students in understanding chemistry concepts.
2. Trimming in class-size should be supplemented by training teachers on newer teaching techniques which will enhance student-teacher interaction which is possible in smaller class-sizes.

References

Anaso J. N. (2017). Chemistry Laboratory Equipment and Senior School Students' Performance in North-Western Nigeria: Implications for Counseling. *Journal of Curriculum and Instruction.* 10(2) 258-270

Anaso, J. N. (2015). Efficacy of Guided Discovery Method on Academic Achievement and Retention of Students in Volumetric Analysis. *International Journal of Research in Science, Technology and Mathematics Education*. 3(2) 15-25.

Aransi W. O. (2017) in Igabai Q. E. (2024). Impart of class-size on Academic Achievement in Secondary School Examinations for Students in Delta State. *Journal of Science Technology and Education* 11 (4) 1-13

Aransi, W. O. (2017). Effect of Class Classification, Class Size and Gender on Academic Predominance among Fatima High School Students in Irewole Local Government Area of Osun State, Nigeria. *European Joumal of Education Studies.* 3 111

Ariz, N. & Farah, N. (2017). A Study on Learning Styles, Gender and Academic Performance of Post Graduate Management Students in India. *International Journal of Economics & Management Sciences*, 6 (1):16.

Ashetu, A. A. (2015). Gender Disparity Analysis in Academic Achievement at Higher Education Preparatory School: Case Study of South Wollo, *Ethiopia. Educational Research and Review,* 10 (1), Pages 50 - 58.

Barthlow, M. J. & Watson, S.M. (2014). The effectiveness Process Oriented Guided Inquiry learning to reduce alternative conceptions in Secondary Chemistry. *School Science and Mathematics,* 14 (5) (246 – 255).

Best, J. W. & Khan J. U. (1989). *Research Education*, Prentice-Hall Inc. New Jersey. FSIR (2003/2004) htp://www.alec.org/2/1/talking_points/2.html7/11/2006.

Igabai, Q. E. (2023). Impart of Class-size on Academic Achievement in Secondary School Examinations for Students in Delta State. *Journal of Science Technology and Education* 11 (4) 1-13

Jibrin, A, G, Mohammad, I., Abdulhamid, A. (2015). Effects of Problem-Solving Strategy and Gender on Academic Achievement of Pre-service Teachers in Genetics for functional Skill Acquisition. *International Journal of Research in Science, Technology and Mathematics Education.* 3(2) 47-54.

Omosor, M. R., Ajaja, O. P. & Kpangban (2024). Adopting the process-oriented guided Inquiry learning method for enhancement of chemistry students' achievement in Delta State. *Journal of Science and Technology Research and Development* 3(2) 23-34

Nnoli, J.N. (2011). Chemistry Pivot for Students Empowerment and Realization of Vision 20.20.20. National Agenda. Implication for Science Teaching. Paper presented at the School of Science Nwafor Orizu College of Education Nsugbe.

C

Nnoli, J. N. (2015) Effect of the use Improvised Organic Reagents on Senior Secondary School Students' Level of Motivation. Achievement and Retention in Chemistry. Unpublished Doctoral dissertation. NnamdiAzikiwe University, Awka, Nigeria.