



Relationship between Class-size and Academic Achievement of Chemistry Students in Secondary Schools in Zaria, Kaduna State, Nigeria

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ABSTRACT

The study investigated the relationship between class-size and academic achievement of chemistry students in secondary schools in Zaria, Kaduna State, Nigeria. The study is quasi-experimental design. The target population is Senior Secondary School II chemistry students in Zaria Metropolis, had sixteen established Secondary Schools with a total number of 4,467 chemistry students. The sample for the study were the Senior Secondary School II chemistry students with a total number of one hundred and fifty (150) chemistry students drawn randomly from three secondary schools in Zaria Metropolis, in Kaduna State. One research and one null hypothesis formulated guided the study. The instrument used was Chemistry Achievement Test (CAT) developed by the researcher. The reliability coefficient of CAT was found to be 0.64. The results obtained indicate that there is significant relationship between class-size and academic achievement of students in the three groups/classes. The result also showed that class-size of 25 is significantly better/higher in achievement than those in other class-size groupings. It is recommended that smaller class-sizes such as 25, 30 and 35 should be encouraged in Nigerian secondary schools to enhance students' academic achievement in chemistry.

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INTRODUCTION

Science is the rationale and systematic study of the environment through experimentation and observation, with a view to understanding the environment in order to manipulate and control it for the betterment of the human race. Science seeks to explain how the universe operates and encompasses the natural (biology, physical chemistry and physics), social and applied sciences. Anaso (2021) see science as an activity culminating in a body of knowledge that is testable, falsifiable, verifiable and has the potential of improving the cultural setting in which it is practiced. Chemistry to Ojokuku (2010) is that part of science that deals with the behavior of matter in relation to their composition and the various changes which they undergo.

Tukuma (2007) agrees that chemistry deals with the study of composition, structure,

properties of matter and the changes which matter undergoes under different conditions and the law which governs these changes. Abbas (2007) added that chemistry is the nucleus of sciences, and the chemists are objective in their observations, recording, pragmatic in their experiment and disciplined in their training. The basic knowledge of chemistry according to Tukuma (2007) is necessary so as to understand the material world in order to exploit its properties for the benefit of humanity. The study of chemistry is very important to mankind. The teaching of chemistry involves developing basic chemistry skills which include observation, manipulation, classification, inference, hypothesizing, interpreting data, formulating model. In addition, the skills and knowledge gained through chemistry should be applied in solving everyday problems in the environment.

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Abdullahi (2007) indicated that one of the aims of teaching science (chemistry in particular) is to enable students understand, retain and use knowledge obtained to solve problems through laboratory work, field work, class work. He added that most teachers unfortunately do not have the capacity to actualize these ideas since they are faced with prevailing students' excesses which often result in the disruption of class work, cheating, and physical aggression. Abdullahi (2007) stressed that student participation in the process skills promotes students' morale, interest and sense of academic self-efficiency. Suleiman (2007) have reported mass failure of students in examinations despite the unique role chemistry plays in the spheres of life. Class-size is one of the variables in this study and it has been a thing of concern among educational researchers for a long time. Some are of the view that class size is an instrument that can be used to measure the performance of the educational system.

The size of a class according to Florida School Indicators Report (FSIR 2003-04) means the count of students meeting in a particular classroom for a class section. 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 is an administrative measure typically defined as the number of students for whom a teacher is primarily responsible for their instruction (as in a self-contained classroom). Most class-size statistics do not address the nature or adequacy of the physical space used for instruction. Ajayi, Audu and Ajayi (2017) are of the view that class size is the number of students per teacher in a class. Adimonyemma, Akachukwu and Igboabuchi (2018) maintain that credence should be given to fewer students in a class in order to promote learning experiences that encourages collaboration and communication among students. In addition, provide helpful learning opportunity and faster student's mental skill discovering.

A number of researchers have reported their findings regarding the relationship between class-size and achievement. Parents believe that

their children would benefit from more individual teacher attention, awareness and this would also translate into higher scores in achievement tests. This implies that the lower the class-size, the higher the academic achievement of students because of high student/teacher interaction.

The relationship between class-size and achievement is stronger at the secondary school level than at the primary school level. Geottler – Sopko (1982) provided a summary of relationship of class-size to achievement hereunder outlined.

- a. small class-sizes seems to result in higher achievement among students who are economically disadvantaged.
- b. students with lower academic ability seem to do better in smaller classes.
- c. class-size might affect students attitudes more significantly than it affects achievement.

Hoxby (2000) illustrated the effect of class-size using Israelite schools and he noted that class-size varies abruptly and predictably when enrollment is at a multiple of 25. These discontinuities provide identification because the difference in the underlying population that produces enrollment of 25 versus 26 is very small and therefore should have corresponding small effect on achievement. But the difference in class-size for enrollment of 25 versus 26 is large and should have a significant effect on achievement if reductions in class-size are efficacious. The same is true for 50, 51, 75 and 76 and so on. It is useful to estimate the effect of class-size only for less-well-off students Hoxby (2000) identified the effects of class-size in student achievement using longitudinal variation in the population associated with each grade in 649 elementary schools using variation in class-size driven by idiosyncratic variation in the population.

Hoxby also used discrete jumps in class-size that occurred when a small change enrolment triggers a maximum or minimum class rule size. The estimates as reported by Hoxby (2000) indicate that class-size does not have a significant effect on students' achievement. James and Robert (2011) in their study on "the impact of class size on the outcomes in higher education"



concluded that reducing class sizes help to improve student outcomes. Raudenbush (2011) who used the Project student-teacher assessment ratio (STAR) data to find out whether reducing class size increased achievement in reading, listening and word recognition skills and whether these effects differed from school to school, reported that reducing class size increased student' achievement in grades K-3 but had minimal improvement in second grade. Evans and Popova (2015) in their study "What really works to improve learning in developing countries? An analysis of divergent findings in systematic reviews". They revealed that there is an impact of class size upon students' performance therefore performance decreases as class size increases. In a study carried out by Olapade (2021) on the implication of large class size in teaching and learning of Business education in Ekiti state, revealed that large class size affects the academic performance of students negatively in tertiary institutions.

Teaching and learning become difficult and reduces seriousness among students. Liz and Lisa (2022) reviewed a study on class size, student behavior and educational outcomes, they reported that students received lower levels of student-teacher interaction and satisfaction in large classes. In conclusion, to offer large classes without sacrificing quality education, they suggested that the school authorities should create more opportunities to encourage more student-teacher interactions. Kushi & Manful (2019) in their study gave statistical evidence which shows that students of all levels of small class size performed better academically than their counterpart in a very large class size. This finding is also in agreement with the work of Amadahe (2016) on a study in assessment and evaluation of students, that large class size requires large number of markings to be done by the teacher and feedback given to the students. Large class is therefore a challenge to the teacher because of overloaded work and the teacher finds it difficult to assess the students effectively. Igabai (2024) in her study on the Impact of Class Size on Academic Achievement in Secondary School Examinations for Students in Delta State reported

a significant relationship between class size and student performance in examination among secondary school students. Anaso (2008) considered the concept of academic achievement 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.

The National Policy on Education (FME 2004) has stated that educational activities should be centered on the learner for maximum self-development and fulfillment. It further stressed that education and training facilities should continue to be expanded in response to societal needs and made progressively accessible to individual students. It is in consonance with these stated goals that the policy (2004) went on to commend an average class of forty students to a teacher. The different literatures cited above showed that there is no conclusion drawn on the effect of class-size on academic achievement of students in the secondary schools. This study is an attempt to find out if there is any significant relationship between class-size and academic achievement of SSII chemistry students in secondary schools in Zaria, Kaduna State, Nigeria.

STATEMENT OF THE PROBLEM

Despite the relative importance of science (chemistry in particular) in national development, it is disturbing to note that the student's achievement in the subject at both internal and external examinations has remained consistently poor. Obiakor and Ogujioffor (2020) revealed that the teacher-student ratio has gone far beyond the stipulation of the national policy on education. Reports of high enrolment and influx of pupils into secondary schools thus resulted in over-crowded classes which have led to student's poor academic achievement in science and chemistry in particular in WASSCE and JAMB examinations over the years. A number of reasons have been advanced by researchers (Obiakor and Ogujioffor 2020; Anaso 2017) as factors for ineffective chemistry teaching. These factors include incompetence of chemistry teachers; lack of commitment of chemistry teachers, inadequate

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apparatus and equipment, to large class-size resulting to high teacher/student ratio among others. The inconclusive result has necessitated for further studies in this area. The focus of this study therefore, is to investigate the relationship between class-size and academic achievement of Senior Secondary School chemistry students in Zaria Education Zone.

Objectives of the Study

The objective of the study is to determine the relationship between class-size and the academic achievement of secondary school chemistry students in Zaria, Kaduna State.

Research Questions

What is the relationship between class-size and academic achievement of secondary school chemistry students when taught chemistry concepts using the guided discovery approach?

Hypothesis

H₀₁ There is no significant relationship between class-size and academic achievement of students when taught chemistry concepts using the guided discovery approach

METHODOLOGY

The study is quasi-experimental design investigating the relationship between class-size and academic achievement of students in Chemistry. The research was a comparative study of three groups of varying class-sizes. This type of design is relevant to a study of this nature in line with Best & Kahn (1985). The design is illustrated thus:

EG₁ ---→ Q₁ ----→ D_A -----→ Q₂
EG₂ ---→ Q₁ ----→ D_A -----→ Q₂
EG₃ ---→ Q₁ ----→ D_A -----→ Q₂

Where;

- EG₁ stands for Experimental Group 1
- EG₂ stands for experimental Group 2
- EG₃ stands for experimental Group 3
- D_A stands for Discovery approach
- Q₁ stands for Pre-test
- Q₂ stands for Post – test

The target population was Senior Secondary School (SSS) II chemistry students in Zaria Metropolis, Kaduna State, Nigeria. There were sixteen Secondary Schools in Zaria Metropolis with a total number of 4,467 chemistry students. The samples for this study were the Senior Secondary School II chemistry students with a total number of one hundred and fifty (150) students drawn randomly from three secondary schools in Zaria Metropolis, in Kaduna State. The three secondary schools were randomly selected with respect to the fact that the schools had covered substantial work/content/topics in the SSSCE chemistry syllabus. The schools were Government Secondary School EG3, Government Secondary School EG2 and Government Secondary School EG1.

In each of the three schools, one formed the small class-size, the second one 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 using even/odd random numbers. This was to ensure that every student had equal chance of participating actively in the study. All the students in the three different schools were taught chemistry concept using the guided discovery approach, which is recommended by the National Policy on Education (FME, 2004).

The instrument used was Chemistry Achievement Test (CAT) developed by the researcher. The Chemistry Achievement Test consist of thirty multiple choice chemistry test items. The purpose of using multiple choice formats was because it allows for wider range and coverage of the content taught. They were validated by a panel of experts that include four chemistry senior lecturers at a university, one science educator and two secondary school chemistry teachers. The test items reflected the four (4) cognitive levels based on Bloom's (1986). The multiple-choice items referred to as the Chemistry Achievement Test were used at two different occasions. Specification of items (that is, topics) used in the study is presented below.

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Table 1: Specification of items (topics used in the study)

Unit	Topic	Number of Questions Chosen
1	Laboratory preparation of alkane.	3,5,6,8,16,17,19
2	Physical properties	9,11,12
3	General preparation of alkene	1, 4, 13,14,21,23
4	General preparation of alkyne	15,22,23,26,27,28,29,30
5	Saturated and unsaturated hydrocarbons	2, 24
6	Isomerism	7, 20
7	Cracking of petroleum	10, 18

A pilot testing was conducted using the Chemistry Achievement Test (CAT) on SSS II chemistry students of Government Secondary School, Zaria. The sample was made up of 50 students. The test items were administered to the students within one hour. The reasons and benefits of pilot testing are to identify problems or difficulties that might arise before the final administration of the instruments to the study samples. Test retest method was employed to determine reliability of the chemistry achievement test. The scores were correlated using Pearson's Product-Moment correlation coefficient. The reliability coefficient of 0.64 was obtained.

Administration of the Treatment

The three comparable groups from the three schools were pre-tested to ensure that the level of understanding of all the study samples were the same and to ascertain their previous knowledge before treatments. The assignment of the various class-sizes was done by stratified random sampling. This was done to ensure that each student has the opportunity of participating

actively in the study and to avoid bias. To achieve the objectives of the study, the students in all the three classes were taught some selected chemistry topics drawn from the SSSCE syllabus using guided discovery method. The lessons were taught to each group during school hours to enable all the study samples participate actively in the research. The researcher personally taught all the groups in order to reduce intervening variable of teacher factor. After 14 teaching periods, a post test was given to all the comparable groups from the three schools (E₁,E₂,E₃). All the test items were the same, except that the options had been interchanged to remove the effect of memorization. The data obtained via CAT were subjected to One-way analysis of variance (ANOVA) to test the hypothesis at P≤0.05 significant level.

RESULTS

The pretest 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	Fcrit	P	Remark
Between groups	14.43	2	7.21	1.71	3.05	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 α = 0.05 with df = 149. The result shows that there is no statistically significant

difference between the achievements 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

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chemistry concepts before the exposure to treatment since the level of significance is 0.05.

Testing H_{01}

H_{01} There is no significant relationship between class-size and academic achievement of students when taught chemistry concepts using the guided discovery approach.

To test this hypothesis, the post-test achievement scores were computed using a one-way analysis of variance and thereafter, there was comparison done within and between the three classes. This is in an attempt to show which group/class-size achieved the best/highest in achievement among the three classes. The results are presented in Tables 3 and 4.

Table 3: One Way Analysis of Variance of Students Post Test Scores among the three classes/groups

Source of variance	Df	Sum of squares	Mean squares	Fcal	P-value	Fcrit	Remarks
Between groups	2	344.60	173.80	9.90	0.000	3.058	S
Within groups	147	2579.89	17.55				
Total	149						

* Significant at $P \leq 0.05$

The results in Table 3 reveals that the critical value is 3.058 while the f-calculated is 9.90 with degree of freedom = 149 at $\alpha = 0.000$. This

shows that the subjects in their post test scores computed differ significantly in their achievement Test at $P \leq 0.05$.

Table 4: Summary of one-way analysis of variance of the student's Post-test scores among the three classes/groups

Groups	Count	Sum	Average mean
Small (Group E_1)	25	352	14.08
Medium (Group E_2)	50	488	9.76
Large (Group E_3)	75	784	10.45

Subjects in group E_1 achieved best with mean score of 14.08 followed by E_3 (10.45) and E_2 achieved the least.

DISCUSSION OF FINDINGS

The study investigated the relationship between class-size and academic achievement of chemistry students at the secondary school level. The subjects before the treatment were pre-tested to determine their equivalence. It was observed from the results (Table 2) that the subjects were equivalent in the knowledge of the chemistry concepts. The hypothesis focused on the academic achievement of students with respect to class-size when taught chemistry concepts using guided discovery approach. The result in Table 3 shows that there is significant relationship between class-size and academic achievement of students in post-test scores. The result shows

that gains were made from the teaching and the results were further subjected to post hoc testing using LSD to determine which class-size achieved significantly higher than the other.

The result in Table 4 indicates that the academic achievement of students in class-size of 25 is significantly better/higher in achievement than those in other class-size groupings. The significant difference in achievement in favor of a small class-size of 25 suggests that class-size of 25 was more appropriate to receive instruction. The findings in this study are in agreement with Raudenbush (2011) and Evans and Popova (2015) who independently reported greater achievements in scores on the post-test though in varying proportions. Also, James and Robert (2011) reported that reducing class-size in schools increases academic achievement. Olapade (2021) in a study carried out on the implication of

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large class size in teaching and learning of Business Education in the state, reported that large class size affected the academic performance of students negatively in tertiary institutions.

Teaching and learning became difficult and reduced seriousness among students. This finding is also in agreement with the findings of Kushi & Manful (2019) that statistical evidence shows that students of all levels of small class size performed better academically than their counterpart in a very large class size. This finding is also in agreement with the work of Amadahe (2016) whose study in assessment and evaluation of students, reported that large class size requires large number of marking to be done by the teacher and feedback given to the students. Large class is therefore a challenge to the teacher because of overloaded work and the teacher finds it difficult to assess the students effectively. Empirical evidences emanating from this study indicate an improvement in academic achievement, the percentage gains across class-sizes were found to be statistically significant. This result therefore suggests that class-size has significant relationship with academic achievement and this has also answered the research question which reads thus "What is the relationship between class-size and academic achievement of secondary school chemistry students when taught chemistry concepts using the guided discovery approach?"

CONCLUSION

The study has shown that there is significant relationship in academic achievement between the three groups/classes. The results indicate that the academic achievement of students in class-size of 25 is significantly higher in achievement than those in other class-size groupings and therefore suggests that class-size of 25 was more appropriate to receive instruction.

RECOMMENDATIONS

The following recommendations are made on the basis of the findings and conclusions emanating from this study:

1. Smaller class-sizes such as 25, 30 and 35 should be encouraged in Nigerian secondary schools to enhance students' academic achievement in chemistry.
2. The makers of the National Policy on Education (FME 2004) should review class size, students and teacher ratio requirement since the recommended class-size of 40:1 appears to be too large for students in understanding chemistry concepts.

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