Achievement Variations of Basic Science Students Taught with Teacher-Centred, Teacher/Student-Centered and Student-Centered Instructions in Kaduna State, Nigeria

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Abstract

This study investigated the effects of teacher-centered, teacher/student-centered and student-centered instruction on the academic achievement of basic science students at the Junior secondary school level, in relation to class-size and gender. A quasi-experimental pretest-posttest research design was used for the study which featured nine comparable groups of basic science students. Four hundred and eighty JSS II students randomly selected from nine schools in Giwa Zone, of Kaduna state formed the study sample. They were taught basic science concepts using the tree types of instruction. Performances of the nine groups were compared using their posttest mean scores. Four null hypotheses were tested using one way Analysis of Variance and t-test at a significance level of P<0.05. Integrated Science Achievement Test (ISAT) with reliability coefficients of and 0.85 was used to collect data for the study. The following findings were established from the study: (i) Students in three different class-sizes taught with student-centered instruction achieved significantly higher than those taught with teacher/student-centered and teacher-centered. (ii) There was no significant difference in performance of male and female students when taught with teacher-centered and teacher/student-centered instruction. (iii) A significant difference was found in the performance of male and female students taught with student-centered instruction with the males performing better than the females. Based on the above findings, recommendations were made among which are the need to train teachers on the use of student- centered instruction in science classrooms.

Keywords: *Teacher, student, instruction, achievement*

Introduction

Science and technology interplay with the society to bring about sustainable development. Nations all over the world, strive to have its citizens educated in Science, Technology, Engineering and Mathematics (STEM) disciplines. Nigeria, as a developing nation has made quite commendable efforts to enhance scientific literacy of its citizens.

Despite the relative importance of science and technology to the country's quest for technological advancement, there is a continuous trend of poor performance in the science subjects and there is also a decline in students' achievement in Integrated Science (13). Many studies such as Agbi (1) have advanced numerous reasons for the decline in students' achievement in Basic science in Nigerian schools. Some of these reasons include poor professional training, poor academic background of the teachers, lack of practical work, lack of students' involvement and inappropriate pedagogies.

Interactions between students and teachers are fundamental to the learning process and the effectiveness of teaching could be influenced by the intellectual quality of classroom interactions,

that is, on the cognitive demands placed on the pupils in the classroom. For students to achieve high in science, the teacher has to use a strategy which will enable the students to understand science concepts and create conducive environment that enhance effective teacher-student interaction.

Students do not learn much just by sitting in class and listening to teachers. Lessons especially Science lessons need to be student centered since science is best learned by inquiry. According to Lara (12), Instructor-centered teaching focuses on the teacher as both authority and model. The instructor determines the content and organization of the course to a great extent. The students are recipients of the instructor's knowledge. Student-centered teaching focuses on the student. Decision-making, organization, and content are largely determined by the student's needs and perceptions. The instructor acts as coach and facilitator. In many respects, the goal of this type of teaching is the development of the student's cognitive abilities.

Interaction whether verbal or non-verbal could be between male and female teachers and students. Patterns of interaction of male and female students have also been reported which reveal significant differences in interaction between boys and girls. Some other research findings exist that suggest that boys are more likely to be provided public response opportunities than are girls (5). They suggested that boys being active, salient and perceived by teachers as potentially disruptive are provided response opportunities as a method of maintaining appropriate classroom discipline. Brophy and Good reviewed many studies and concluded that boys tend to have more interactions of all kinds with their teachers than girls do and initiated more contact with the teacher and were more forceful and assertive at gaining teachers' attention. This they considered as a major factor that contributes to high achievement in boys.

A number of researchers, for example Bassey (3); Iroegbu (11) and Shaibu (17), have attributed students' poor academic achievement in science in the secondary schools to large class-size. The National Policy on Education (7) defines class- size as the population of a given class in terms of number of students and recommends an average class-size of 40 learners to a teacher. In the present study, a large class is defined as one having a student population ratio of 75 – 90 students to one teacher, medium class-size is considered to be one with student population of 50 – 65 students while a small class-size is considered to be one with 25 – 35 students.

The National Policy of Education (7) recommendation of an average class-size of 40 learners to a teacher is hardly tenable in Nigerian Schools. Duyilemi (6) for example observed that class-size ranging from fifty (50) to an unbelievable figure of one hundred and twenty (120) students are found in some secondary schools. He further explained that in some cases one or two students within a group may tend to dominate whereas the others may exhibit passive behaviours, such as observing or copying, even though the general goal is to involve all the students equally in class activities.

With the introduction of Universal Basic Education in 1999, there has been a great influx of children into schools in Nigeria. There has not been commensurate expansion of facilities including human resources. The Nigerian science teacher is thus faced with a herculean task of handling large classes and yet keeps students focused and interested. This study therefore set out to investigate the effect of teacher-centered instruction (i.e. a situation where student listen while the teacher talks), teacher/student-centered instruction (a situation where teacher dominates the lesson half way and the remaining part of the lesson allows student to dominate class discussions), student – centered instruction (where students are allowed to dominate class discussions with teacher serving only as a guide) on the academic achievement of male and female basic science students in different class-sizes and in different ability groups.

Specifically, the study sought answers to the following Research Questions:

1. What is the effect of teacher-centered instruction, teacher/student-centered and student-centered instruction on the academic achievement of male and female basic science students?
2. What is the effect of teacher-centered, teacher/student-centered and student – centered instruction on the academic achievement of basic science students in large, medium and small class-sizes?

Hypotheses

Based on the research questions, the following null hypotheses were formulated for testing:

HO1a: There is no significant difference in the academic achievement of male and female Basic science students exposed to teacher-centered instruction.

HO1b: There is no significant difference in the academic achievement of male and female Basic science students exposed to teacher/student- centered instruction.

HO1c: There is no significant difference in the academic achievement of male and female Basic science students exposed to student- centered instruction.

HO2: There is no significant difference in the academic achievement of Basic science students in large class-size, exposed to teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

HO3: There is no significant difference in the academic achievement of Basic science students in medium class-size, exposed to teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

HO4: There is no significant difference in the academic achievement of Basic science students in small class-size, exposed to teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

Method of Data Collection

A quasi-experimental design involving pretest and posttest (16) was adopted for this study. In the study, 480 students divided into nine comparable groups of students, selected by random sampling from 20 schools in Kaduna state, were used for the study. Three groups of 35 students (20 males and 15 females) each (representing small class-size), three groups of 50 students (25 males and 25 females) and three groups of 75 students (40 males and 35 females) each (representing large class-size).

The instruments used for this study were Integrated Science Achievement Test (ISAT) with a reliability coefficient of 0.85, adopted from Inyang (10) (and used by Usman, (19). The Integrated Science Achievement Test consists of a set of forty multiple choice test items designed to reveal the extent to which students have understood the topics selected in Integrated Science (Basic science).

A pretest was conducted on the sample subjects in the nine schools using the Integrated Science Achievement Test (ISAT). This is to ensure comparability in ability level of the subjects for the study. The pretest scores were subjected to a one-way Analysis of Variance (ANOVA) and tested at $P<0.05$ level of significance. No significant difference was obtained in the pretest scores of all subjects indicating comparability and equivalence of all the nine groups at the start of the study.

The nine groups (Ltc, Ltsc, Lsc, Mtc, Mtsc, Msc, Stc, Stsc, Ssc) were then taught for six weeks on Basic Science concepts (Ecology, Energy and Method of Separating Mixtures) utilizing teacher-centered instruction, teacher/student-centered instruction and student-centered instruction for each of the three class-sizes respectively (for instance Group Ltc was a group of students in large

class-size taught, using Teacher-centered instruction). A posttest was administered after teaching the groups, marked and data collated for analysis.

Results

Data were subjected to statistical analysis based on formulated hypotheses.

HO1a: There is no significant difference in the academic achievement of male and female students exposed to teacher-centered instruction.

This hypothesis was analysed using t-test statistic. The result is shown on Table 1a.

Table 1a: *t-test Analysis of Posttest Mean Scores of Male and Female Subjects Exposed to Teacher-centered Instruction.*

Groups	N	Mean	df	SD	t	P-value
Male	88	12.500	147	3.74	1.848^{NS}	0.067
Female	61	11.328		3.89		
Total	**149**					

NS Not significant at P< 0.05

From Table 1a, the calculated t-value is 1.848, and p-value is 0.067 obtained at α = 0.05, df 147. Since the p-value 0.067 is greater than 0.05, it means that there is no significant difference between the posttest mean scores of the male and female subjects exposed to teacher-centered instruction.

The null hypothesis HO1a was therefore retained and this implies that Teacher-centered instruction is gender friendly since male and female subjects achieved equally.

HO1b: There is no significant difference in the academic achievement of male and female students exposed to teacher/student-centered instruction.

This hypothesis was analysed using t-test statistic. The result is shown on Table 1b.

Table 1b: *t-test Analysis of Posttest Mean Scores of Male and Female Subjects Exposed to Teacher/Student-Centered Instruction.*

Groups	N	Mean	df	SD	t	P-value
Male	89	18.348	147	4.46	-0.333^{NS}	0.740
Female	60	18.600		4.63		
Total	**149**					

NS Not significant at P< 0.05

Result of the analysis in Table 1b shows t-calculated as -.333 and p-value is 0.740 obtained at α = 0.05, df 147. Since the p-value 0.740 is greater than 0.05 it means there is no significant difference between the posttest means of the male and female subjects exposed to Teacher/Student-centered instruction.

The null hypothesis HO1b was therefore retained and in this respect Teacher/Student-centered instruction is gender friendly.

HO1c: There is no significant difference in the academic achievement of male and female students exposed to student-centered instruction.

This hypothesis was analysed using t-test statistic. The result is shown on Table 1c.

Table 1c: *t-test Analysis of Posttest Mean Scores of Male and Female Subjects Exposed to Student-Centered Instruction.*

Groups	N	Mean	df	SD	t	P-value
Male	89	22.169	148	6.9122	3.082^{S}	.002
Female	61	18.803		6.0327		
Total	**150**					

S Significant at P $\leq$ 0.05

The results of analysis presented in table 1c shows the calculated t-value to be 3.082 at α = 0.05 df 148. The p-value 0.002 being less than 0.05 shows that there is a significant difference between the posttest mean scores of the male and female subjects exposed to student-centered instruction. From the means of the two groups indicated in Table 1c, the males performed better than the females.

The null hypothesis HO1c was thus rejected showing that there is a significant difference in the scores of male and female students taught with teacher-centered instruction, teacher/student-centered instruction and student-centered instruction. .

HO2: There is no significant difference in the academic achievement of Basic science students in large class-size, exposed to teacher-centered instruction, teacher/student-centered and student-centered instruction.

To test this hypothesis, the posttest achievement scores were subjected to one way Analysis of Variance to show which group achieved highest among the three large class sizes. The results are presented in Tables 2a and 2b.

Table 2a:*Summary of Students Posttest Scores among the Three Groups (L_{tc},L_{tsc},L_{sc}).*

Groups	Count	Sum	Mean
$\mathbf{L_{tc}}$	75	885.0	11.800
$\mathbf{L_{tsc}}$	75	1349.0	17.987
$\mathbf{L_{sc}}$	75	1381.0	18.413

Key $\mathbf{L_{tc}}$ = Large class-size exposed to teacher-centered instruction
$\mathbf{L_{tsc}}$ =Large class-size exposed to teacher/student-centered instruction
$\mathbf{L_{sc}}$= Large class-size exposed to student-centered instruction

Table 2a shows that subjects in group Lsc achieved highest with mean score of 18.413, followed by Ltsc (17.987) and Ltc (11.800) achieved the least. This therefore implies that student-centered instruction is the best to apply in a large class-size.

Table 2b: *One Way Analysis of Variance of Students Posttest Scores among the Three Groups.*

Source of variance	Sum of squares	df	Mean squares	F-ratio	P-value
Between groups	2054.827	2	1027.413	39.631^{*}	0.001
Within groups	5755.173	222	25.924		
Total	7810.000	224			

*Significant at P<0.05

Table 2b reveals the calculated F-value to be 39.631 with degree of freedom = 224 at α = 0.05 level of significance. The p-value (0.001) obtained being less than 0.05 shows that there is significant difference in the performance of subjects in their posttest scores at P<0.05 level of significance. Table 2a shows the direction of the difference.

The null hypothesis HO2 was thus rejected showing that there is a significant difference in the scores of students in large class-size, taught with teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

HO3: There is no significant difference in the academic achievement of Basic science students in medium class-size, exposed to teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

To test this hypothesis, the posttest achievement scores were subjected to one way Analysis of Variance to show which group achieved highest among the three medium class sizes. The results are presented in Tables 3a and 3b.

Table 3a: *Summary of Students Posttest Scores among Groups in Medium Class-Sizes*

Group	Count	Sum	Mean
M_{ts}	50	522	10.440
M_{tsc}	50	911	18.220
M_{sc}	50	1051	21.020

key **M_{ts}** = Medium class-size exposed to teacher-centered instruction.
Mt_{sc} =Medium class-size exposed to teacher/student-centered instruction
M_{sc} = Medium class-size exposed to student-centered instruction

Table 3a shows that subjects in group Msc achieved highest with mean score of 21.020, followed by Mtsc (18.220) and the least Mtc (10.440).

Table 3b: *One Way Analysis of Variance of Students Posttest Scores among the Three Group, in Medium Class-Sizes*

Source of variance	Sum of squares	df	Mean squares	F -ratio	P-value
Between groups	3005.080	2	1502.540	83.039*	0.001
Within groups	2659.880	147	18.094		
Total	5664.960	149			

*Significant at P < 0.05

The result in Table 3b shows that the calculated F value is 83.039 at α = 0.05, df 149. The p-value 0.001 being less than 0.05 implies a significant difference in the posttest scores of students.

The null hypothesis HO3 was therefore rejected showing that there is a significant difference in the scores of students in medium class-size, taught with teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

HO4: There is no significant difference in the academic achievement of Basic science students in small class-size, exposed to teacher-centered instruction, teacher/student-centered instruction and student-centered instruction.

One-way ANOVA was used to test this hypothesis. The results are shown in Tables 4a and 4b.

Table 4a: *Summary of Students Posttest Scores among Groups in Small Class- Sizes*

Groups	Count	Sum	Mean
S_{tc}	25	391	15.640
S_{tsc}	25	508	20.320
S_{sc}	25	686	27.440

Key: S_{tc} = Small class-size exposed to teacher-centered instruction
S_{tsc}= Small class-size exposed to teacher/student-centered instruction
S_{sc}= Small class-size exposed to student-centered instruction

Table 4a shows that subjects in group Ssc achieved highest with a mean score of 27.440, followed by Stsc (20.320) and Stc (15.640) which achieved the

Table 4b: *One Way Analysis of Variance of Students Posttest Scores among the Three Groups in Small class-Sizes*

Source of variance	Sum of squares	df	Mean squares	F-ratio	P-value
Between groups	1765.307	2	882.653	40.755*	0.001
Within groups	1559.360	72	21.658		
Total	3324.667	74			

*Significant at < 0.05 level

The result from table 4b indicate the F-calculated as 40.755 at $\alpha = 0.05$, df 74. The p-value 0.001, being less than 0.05, shows that there is a significant difference in the posttest scores among the groups.

The null hypothesis HO4 was thus rejected showing that there is a significant difference in the scores of students in small class-size, taught with teacher-centered instruction, teacher/student-centered instruction and student-

Discussion

Null hypotheses 1a and 1b focused on effect of teacher-centered instruction on achievement of male and female basic science students. Result of the analysis testing these hypotheses show no significant differences in the mean scores of male and female students exposed to teacher-centered and teacher/student-centered instruction. [Tables 1a and 1b]. This implies that boys and girls exposed to these types of instructions not differ significantly in their academic achievement. This could be explained by the fact that since the teacher dominated the classroom talk in the first

instance and students were given opportunity to initiate and dominate classroom discussions (in the case of teacher/student-centered instruction), each gender had equal opportunities available to them. No gender group had opportunity to be interactive at the detriment of the other group which could have resulted to a higher performance on their part.

The equivalent performance of both boys and girls reported in this study in line with the studies of Ogunboyede (14). This report however is in disagreement with Harding and Whiteleg (8), Usman (19), Aigboman (2), who reported in their various studies that boys performed significantly better than girls in science. The result of this study implies that teacher-centered and teacher/student –centered instruction are gender friendly and should be encouraged in science classrooms that mixed-gender.

Hypothesis 1c focused on effect of student-centered instruction on academic performance of male and female students. Analysis of results testing this l Hypothesis indicate a significant difference in the posttest mean scores of male and female students exposed to student-centered instruction [Table 1c]. From the analysis, males performed significantly better than the females.

This result agrees with the findings of Tambaya (18) who reported a significant difference in the achievement of boys and girls exposed to high level teacher-student verbal interaction. However results of this study disagree with that of Bichi (4), Ogunboyede (14) who independently reported that boys are not better than girls in their academic achievement.

The findings of this study reveal that gender differences in science achievement levels could be influenced by the type of instruction adopted by the science teacher especially in whether it is teacher-centered, student-centered or both. The higher performance by boys taught with student-centered instruction could be as a result of the fact that most girls in the Northern part of the country naturally shy away from class verbal interaction in mixed classrooms and did not get enough opportunity to participate in class discussions and demonstrations like the boys.

However this study has clearly revealed the efficacy of student-centered instruction in both male and female students. Looking at the means of the male and students exposed to the three different types of instruction namely; male (teacher-centered), mean = 12.5000, male (teacher/student- centered), mean = 18.348, male (student centered), mean = 22.169. For the fact that males taught with student-centered instruction had the highest means shows a positive effect of this type of instruction even within the same gender. This is further asserted by the results reported by this study on females viz; female (teacher-centered) 11.328, female (teacher/student-centered) mean = 18.600 and female (student centered) mean = 18.803. Student-centered instruction should thus be encouraged for science classes especially in single sex classrooms.

Hypotheses 2, 3 and 4 focused on effects of type of instruction in relation to class-size. Results of the analyses in Tables 2, 3 and 4 indicate significant differences in the posttest scores of subjects in large, medium and small class-sizes, exposed to the three types of instruction under discussion. The results reveal that subjects exposed to student-centered instruction in large, medium and small class-sizes performed significantly better than the other groups. This could be as a result of increase in interest and enthusiasm of students in classrooms where student-centered instruction is utilised thus leading to higher performance among this group. This indicates that student-centered instruction is important for effective learning of basic science concepts.

This report is in agreement with earlier findings by Olajide (15), Tambaya (18) who reported positive educational outcomes through allowing students to actually participate in verbal communication in classrooms. The report also agrees with Inamullah, Hussain and Din (9) who reported that teacher verbal domination of the classroom conditions students to become passive and dependent on the teacher. Their findings further suggest that this dependency has adverse effects on students' attitudes towards learning and consequently students' performance in school.

Conclusion and Recommendations

The nature of science demands active participation by learners during lessons. This study has confirmed this fact with students taught with student-centered instruction performing better than others. However the study has also revealed an important issue to consider. Student –centered instruction does not favour females in mixed gender science classrooms and should not be used in such classes. However if the science teacher has a way of controlling students' participation to ensure that girls are given equal opportunities with boys, then student –centered instruction can be used in all science classrooms, otherwise science classes should be single sex. Science teachers need to be trained on te art of using this type of instruction in teaching science.

This study concludes with these questions; will student-centered instruction always enhance academic performance in other scientific concepts apart from the ones used in this study? Will it always enhance academic achievement in science irrespective of tribe, race or culture of students? This calls for further research.

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