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Ac. J. Psy. Stud.
Vol. 3, Issue 3, 207-217, 2014
ISSN 2333-0821

Academic Journal of Psychological Studies
www.worldofresearches.com

ORIGINAL ARTICLE Receivedv29 Feb. 2014 Accepted 10 Apr. 2014

Effects of Instructional Strategies and Gender on Basic-Science Students' Achievement in Nigeria

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ABSTRACT: The study examined the effect of instructional strategies (inquiry, demonstration and lecture), ability levels and gender on students' achievement in the learning of Basic science in Nigeria secondary schools. 270 junior secondary school students (128 males and 142 females) of 6 selected schools in Delta central senatorial district of Delta State were sampled for the study. High and Low Ability students were gotten using the pretest of the achievement test. The instruments for data collection are the teaching guides and the Basic Science Students Achievement Test (ISSAT). For all the overall achievement of high and low ability students in all the instructional groups, there were significant differences –the high ability group did better than the low. No significant difference was found in the overall achievement of male and female students taught Basic science in all the groups. It was recommended that science teachers should develop a spirit of inquiry among all science students paying extra attention to the low ability while not discouraging the high ability students as well as continuing to ensure gender bias is de-emphasized in the science classrooms.
Key words: Instructional Strategies, Gender, Ability Levels, Basic Science, Achievement

INTRODUCTION

Students understanding of scientific knowledge are developed when they are actively involved and engaged in scientific inquiry. Naturally when students have understanding of scientific concepts they will perform better academically. When science teachers plan an inquiry based approach the interest of the student is increased and his understanding improved. As teachers are trying their best to see that their students do well in sciences, it is seen that this dream is still far from been realized. Several studies in Nigeria revealed that the performance of students in science is generally poor[1, 2, 3] and several reasons were given for this which includes teaching methods[4, 5, and 6]. Researchers comparing students performances using different teaching methods have found that students performs differently when different teaching methods are used[7] and the performance of students of different ability levels and gender differs when they are compared using different teaching methods[8,9,10,11].

In 1970 when the first newsletter by the Nigeria Integrated Science Project (NISP) was published, it was specified that integrated science students should

exhibit the skills of observing carefully and thoroughly, organize information acquired by observing and use the process of inquiry to confirm predictions and For the student to be able to achieve these skills they should be taught with inquiry strategies, open ended laboratory exercises and use of discovery tactics. It can be deduced from the specifications of the NISP that the inquiry method best suits the highlighted skills and strategies for teaching students Basic science. The present Basic science according to Oludipe[3] is given great emphasis in the junior secondary school curriculum and amongst reasons for the introduction of the subject in Nigeria is enhancing scientific literacy of the citizenry, however of great concern in the field of science education are the biases and misconceptions about women and science that science is a male enterprise .

Most of the problems of science teaching in Nigeria schools today are attributed to teacher's inability to help students learn science in a meaningful way. It is the teacher's duty to ensure all students irrespective of sex and ability level have equal right and opportunity to learn science. In science teaching today's there is a shift from emphasizing the traditional lecture method to more practical student activity methods. Hence Onyegegbu[12] is of the opinion that the destiny to a nation is shaped in its classroom and that individual differences exist among the students. The teacher is an important instrument in bridging this difference and molding that destiny.

On gender differences according to Okoye11 the various biological differences in human make-up particularly between male and female human beings in most cases have led to the suspicion that one sex may have a "learning edge" over the other sex, that because men are regarded as the dominant and even superior sex, they learn much better than women. According to Oludipe3 the issue of gender is an important one in science education especially with increasing emphasis on ways of boosting manpower for technological development this is one reason science education researchers are focusing on the influence of gender factors on students' academic achievement in basic science when they are taught using different instructional strategies and different results have been seen. It is however argued that certain teaching methods will reduce gender bias and encourage everyone to be fully involved in science classroom activities. One of such is the discovery or inquiry approach. Approaches like traditional classroom methods have been found to have effect of gender on students' achievements [7] because students are passive and this passive nature discourages students to further in their learning of science. Uhumuavbi and Mamudu[13] carried out a research on effects of programmed instruction and demonstration methods on students' academic performance in science and found out that: There is significant difference between the academic performance of male and female exposed to demonstration method with the female students performing higher than the male students in the demonstration method. Reasons given for the results was

attributed to the fact that male students believe that the harder sciences like physics, chemistry and mathematics are meant for them into such professions like engineering, meteorology, architecture while female students feel more at home with science subjects like biology, health science which would lead them into such professions like nursing, teaching, health workers. This means that the effect of gender varies from subject varies from subject to subject. Adekoye and Olatoye [14] also agreed that the effect of gender varies from subject to subject but their findings on the effect of gender on an aspect of Agricultural science using demonstration method revealed that males performed better than female students.

Ganiyu and Isaac[15] carried out a study on gender influence on biology students" concept-mapping ability and achievement in evolution and their findings

Revealed that there is no gender influence on students' concept-mapping ability and their achievement in evolution that is ability to construct good concept maps is not limited to any student gender. However, the percentage of' male students that constructed good concept maps was slightly higher than their female counterparts. From the reviews above there have been conflicting reports in respect to gender and achievement in science and this study is expected to contribute to the debate.

On ability groups Hoffer[16] found out that when students are grouped, the high ability students benefit more in the learning process than the slower ones. As Adodo and Agbayewa[17] explains it is best to use strategies that will give high and low science achievers in science the extra help they would need without dampening the interest and progress of the brighter students in the classroom setting. Ganiyu and Isaac[15] discovered in their study on ability groups that: there was no significant difference between the achievement of high-scoring male and female students; no gender difference occur in high-scoring students' achievement in evolution; achievements in evolution of average-scoring male and female students do not differ significantly; there is no statistically significant difference between the achievement in evolution of low-scoring male and female students. Contrary to their findings, Nkoju and Jacks [10] discovered that low ability students experience more difficulty than high ability students in acquisition of practical skills. Adesoji[18] investigated the impact of problem-solving instructional strategy on the performances of students of different ability levels in Chemistry. It was detected that there was no significant difference in the performance of students in the different ability levels. It was also detected that method of instruction influence academic achievement of low achievers. Therefore the need for good instructional strategy like problem-solving technique was advocated for teachers of science. This would go a long way in improving problem-solving skills of students no matter their ability levels. There are conflicting results on the effects of different instructional strategies on achievements of students of varying ability levels[19, 20]. It is also one reason this study was carried out to contribute to this debate as well .

In a clear statement the problem of this study posed as a question is: Which of the two instructional strategies (inquiry and teacher-demonstration) will enable

male and female students of different ability levels to achieve more scientific concepts when taught Basic science ?

The following questions and hypotheses were raised to guide this study:

R1. Are there differences in the overall posttest achievement of students of high and low ability levels taught basic-science?

R2. Are there differences in the overall achievement of male and students taught Basic-science?

Ho 1. There is no significant difference in the mean achievement scores of high and low ability students taught integrated science with inquiry, demonstration and lecture strategies

Ho2. There is no significant difference in the mean achievement scores of male and female students taught Basic science with inquiry, demonstration and lecture strategies.

MATREALS AND METHODS

The study employed a "3x2x2" factorial design with instructional strategies at 3levels (inquiry, demonstration and lecture), ability at 2 levels (high and low) and gender at 2 levels (male and female). The population for the study was all secondary school students of Delta central senatorial district of Delta state Nigeria and the sample consist of 270 junior secondary two (JSS 2) students of 6 selected secondary schools that met with the selection requirement for the study. The sample consists of 128 males and 142 females. Ability levels were of High and low ability students. The ability levels were arrived at using the results gotten from the pretest administration. Intact classes were used in order not to disrupt the schools normal teaching activities. The instruments for data collection are the teaching guides for lessons based on the 3 instructional strategies (inquiry, demonstration and lecture) and the Basic science students achievement test (ISSAT) .

The content of the teaching guides and objectives were the same for all the groups although the teaching approaches were different depending on the method used. The topics taught were skeletal system, muscular system and digestive systems .

The inquiry groups were taught using the inquiry approach where the teaching was purely student centered. The demonstration was both teacher and student centred, while the lecture was purely teacher centered.

The evaluation questions forming the ISSAT were from past questions selected from junior certificate exams and were re-validated by a panel of senior researchers from the field of Science education, measurement and evaluation and a Basic science teacher with 10 years' experience in marking junior certificate

examination in Nigeria. The reliability was determined by conducting a pilot test on 30 students who did not form part of the sample used for the study.

RESULTS

The descriptive data for the pretest and posttest means of students in the three groups are presented below.

Table 1. Distribution of subject sample for the study

		Ability levels (Inquiry)		Demonstration		Lecture		total
		High	low	high	low	high	low	
Gender	male	15	25	18	22	28	20	128
	female	23	27	23	27	21	21	142
Total		48	52	41	49	49	41	270

The table 1 shows the spread of the subject used for the study in the various instructional strategy and gender as well as ability groups. The total sample is 270 students.

Table 2. Pretest and Posttest means

Groups	Post-test means	Pretest means	Difference between post and pretest
Inquiry	24.17	8.09	16.08
Demonstration	15.56	8.86	6.7
Lecture	16.61	9.00	7.61

From the table ii above it is seen that the mean difference of the inquiry, demonstration and lecture groups were 16.08, 6.7 and 7.61 respectively this means treatment had more effect on the inquiry group followed by the lecture then the demonstration group. It therefore means that students taught using the inquiry method did better than the other groups.

Answer to research questions 1 and 2:

In answer to the research questions table 2 above and tables 3 and 4 below shows the posttest means and standard deviation for the groups and factors .tables 3 and 4 also show the t-test result for any two groups but with respect to gender and ability group.

Table 3.table showing t-test result for any 2 groups with respect to ability levels

s/n	Groups	N	X	SD	df	t-cal	t-cri	Remark
GP1.	High ab.(all)	128	20.01	5.27	178	5.01	1.96	Signi. Diff
	Low ab.(all)	142	17.71	4.73				
GP2.	Inquiry high	38	26.13	3.59	88	4.62	1.98	Signi. diff
	Inquiry low	52	22.75	3.19				
3	Lectur high	49	18.32	2.69	88	6.75	1.98	Signi .diff
	Lecture low	41	14.56	2.58				
4	Demo. High	41	16.36	3.88	88	1.55	1.98	Not signi.
	Demo. Low	49	15.22	2.94				
5	Inquiry high	38	26.13	3.59	85	11.19	1.98	Signi. Diff
	Lectur high	49	18.32	2.69				

6	Inquiry low Lecture low	52 41	22.75 14.56	3.19 2.58	91	13.69	1.98	Signi. diff
7	Inquiry high Demo. High	38 41	26.13 16.36	3.59 3.88	77	11.62	1.98	Signi. diff
8	Inquiry low Demo. Low	52 49	22.75 15.22	3.19 2.94	99	12.34	1.98	signi. diff
9	Lecture high Demo. High	49 41	18.32 16.36	2.69 3.88	88	2.81	1.98	signi. diff
10	Lecture low Demo. low	41 49	14.56 15.22	2.58 2.94	88	0.83	1.98	Not signi.

Answer to research question one

R1:Are there differences in the overall posttest achievement of students of high and low ability levels taught Basic science?

There is a difference in the overall achievement of high and low ability students as seen in the group 1 in the table iii. The high ability students have a higher mean score of 20.01 against the low with a mean score of 17.71.

R2: Are there differences in the overall achievement of male and students taught Basic science.

From table iii, that there are differences since the mean score for the male is 18.88 while that of females is 18.45. Hypotheses 1 & 2, shows the test for significant difference.

Test of Hypothesis one:

Hypotheses one states that there is no significant difference in the mean achievement scores of high and low ability students taught integrated science with inquiry, demonstration and lecture strategies. Analysis of result in the overall achievement of high ability versus low ability students' shows T-test analysis revealing that the difference is significant at 0.05 level of significance (t-cal is 5.01, t-cri is 1.96, since t-cal is greater, there is a significant diff). Based on this hypothesis one is rejected.

Within the groups, (groups 2-4):

From the table 3 above it is seen from t-test analysis that within the inquiry and lecture groups respectively significant differences exist. This means high ability students did significantly better than low ability students and that method favored high ability students over the low ability students in the lecture and inquiry groups. However in the demonstration group there were no significant difference between high and low ability students meaning the method favored both high and low ability students.

Between the groups (groups 5-10):

T-test analysis revealed that significant differences occurred in high ability students between any 2 groups, similarly significant differences occurred in low ability students between any 2 groups except in the lecture and demonstration group. There was no significant difference between low ability students in the lecture group and low ability students in the demonstration group.

Table 4. Result of t-test analysis with respect to gender.

s/n	Groups	N	X	SD	Df	t-cal	t-cri	remark
Group1	All male	128	18.88	5.13	178	0.66	1.96	Not Signi.
	All female	142	18.45	5.58				
Group2	Inquiry male	40	24.75	3.57	88	1.32	1.98	Not
	Inquiry female	50	23.72	3.86				Signi.
Group3	Lecture male	48	16.95	3.14	88	1.08	1.98	Not Signi.
	Lecture female	42	16.21	3.29				
Group4	Demonstr. Male	40	15.32	2.93	88	0.21	1.98	Not signi.
	Demonstr. female	50	15.46	3.23				
Group5	Inquiry male	40	24.75	3.57	86	10.77	1.98	Signi. diff
	Lecture male	48	16.95	3.14				
Group6	Inquiry female	50	23.72	3.86	90	10.07	1.98	Signi.diff
	Lecture female	42	16.21	3.29				
Group7	Inquiry male	40	24.75	3.57	78	9.43	1.98	Signi.diff
	Demonsr.male	40	15.32	2.93				
Group8	Inquiry female	50	23.72	3.86	98	11.61	1.98	signi.diff
	Demonstr. Female	50	15.46	3.23				
Group9	Lecture male	48	16.95	3.14	86	2.52	1.98	signi.diff
	Demonsr.male	40	15.32	2.93				
Group10	Lecture female	42	16.21	3.29	90	1.09	1.98	Not signi.
	Demonstr.female	50	15.46	3.23				

Test of Hypothesis Two:

Hypothesis two says that there is no significant difference in the mean achievement scores of male and female students taught Basic science with inquiry, demonstration and lecture strategies.

T-test analysis of result in the overall achievement of male and female student revealed no significant difference exists. T-cal at 0.66 is lower than t-cri at 1.96 this makes hypothesis one accepted.

Within the groups (group 2-4):

No significant difference occurred. All male and female students within the various group performed similarly irrespective of the method used. This means method did not have effect on gender within each instructional strategy.

Between any 2 group (5-10):

There were significant differences in the performances of males versus males and females versus females between any 2 instructional groups. All t-cal were greater than the t-cri values. Males in inquiry did better than males in the other groups, similarly females in inquiry did better than their females counterparts in

the other groups, except in the female lecture and female demonstration group(gp10) where no significant difference exist.

Summary of findings for ability groups

1. For all the overall achievement of high and low ability students in the two experimental groups there was a significant difference –the high ability group did better than the low with a t-test value of 5.01 against a table value of 1.96. Therefore hypothesis one was rejected.

2. Within the groups

i. There was a significant difference between high and low ability students in the inquiry group. The high ability did better.

ii. There was a significant difference between high and low ability students in the lecture group. High did better.

iii. There was no significant difference between high and low ability students in the control (demonstration) group.

3. Between any two groups(high abilities)

i. Significant difference between inquiry high and lecture high. Inquiry did better.

ii. Significant difference between inquiry high and demonstration high. Inquiry did better

iii. Significant difference between lecture high and demonstration high. Lecture did better.

(Low Abilities)

iv. Significant difference occurs between inquiry low and lecture low. Inquiry did better

v. Significant difference occurs between inquiry low and demonstration low. Inquiry did better.

vi. No significant difference occurs between lecture low and demonstration low. Both did equally poor but demonstration low had slightly higher mean.

Summary of findings for gender

1. No significant difference in the overall achievement of male and female students taught integrated science in all the groups. T-calculated value was 0.66 against the table value of 1.96. Therefore hypothesis two was accepted.

Within the groups (between male and female)

1. No significant difference between male and females within the respective groups.

Between any two groups (male and male) and (female and female)

1. Significant difference between male and male in any two groups.

2. Significant difference between female and female in any two groups except between demonstration female and lecture female there was no significant difference between demonstration female and lecture female.

DISCUSSION

Analysis of hypothesis one revealed there are significant differences in the mean achievement scores of high and low ability students taught integrated science with inquiry and lecture strategies. The high ability students did better in all the groups except in the demonstration group where no significant difference occurred. This result is in contrast with the findings of some researchers[8,15] , that there are no significant differences in students' achievement and ability levels when inquiry or other student centred approaches were used and when the lecture approach was used [16,17]. The demonstration method seems to favor both the high and low ability students because the high and low students were opportune to participate in the practical demonstrations of all the lessons taught and the teachers took time to involve mostly the low ability students during demonstrations. Although the demonstration method favored high and low ability students nevertheless the students in this group had the least performances when taught Basic science. Also, there were differences between high and low inquiry students, nevertheless the high and low ability students of inquiry performed better than the high and low ability students of the other two groups making inquiry still better than the other groups. It is therefore suggested by the researcher that the teachers using inquiry group should pay attention to the low ability students while making sure the high ability students are not underutilized. This was also suggested by Adodo and Agbayewa[17] that teachers should find how best to give the low ability students the extra help they would need without dampening the interest and progress of the brighter students in the classroom settings.

For gender differences there were no significant differences between male and females in all the groups. This means in teaching students integrated science using any of inquiry, lecture or demonstration strategies no gender differences exist. This is in line with findings of other researchers [14, 15] and at variance with findings of other researchers that gender differences exist with different instructional strategies[8, 9.10]. The results on gender also shows that males in inquiry did better than males in other groups and females in inquiry did better than females in other groups making inquiry still the best approach to use.

The following recommendations are made based on the findings of this research.

1. Educational planners should re-emphasize the development of a spirit of inquiry among science students.

2. Science teachers should continue to ensure gender bias is de-emphasized in the science classrooms using inquiry-based approaches.

3. Teachers using inquiry methods should pay attention to the low ability students while making sure the high ability students are not underutilized during science classes.

4. Science teachers should spent after-class instructions with the low ability students leisurely not as compulsion.

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