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Full Length Research Paper

Cognitive effects of curriculum model and school type on science learning: Implication for production of quality young scientists

Moemeke, Clara Dumebi[1]* and Konyeme, Josephine Ese[2]

[1] Department of Curriculum Studies and Educational Technology, College of Education, Agbor, Delta State, Nigeria.

[2] Integrated science Department, College of Education, Agbor, Delta State, Nigeria.

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The study focused on determining the influence of curriculum models and school type variables on students' cognitive learning outcome in science. Opinions vary as to variables that affect science learning outcomes among boys and girls. Research reports have also contradicted one another on the disparity that exists between the sexes in achievements in science and in participation in science occupations. This study is an attempt in establishing empirically the effect of these variables on science learning outcome as well as proffer possible remedies to poor science achievement among learners. Four null hypotheses were tested in the study. Two hundred and ten (210) SS2 science students in nine intact classes from three secondary schools (one from each senatorial zone) in Delta state, Nigeria were taught six concepts in biology using three curriculum models (Traditional Expository Approach (TEA), Hypothetico-Predictive Learning Cycle (HPLC) and Descriptive Learning cycle (DLC)) for ten weeks. The three sampled schools consist of one All-boy, one All-girl, and one coeducational school respectively. A 3x3x2 factorial design was employed while data was collected using three instruments (Test of scientific reasoning skill, test of attitude towards science, and test of achievement in science). The resulting data were subjected to Analysis of Variance (2-way ANOVA) with repeated measures as well as graphical display. Result showed that while outcome varied along test types, with attitude most favoured, there was no interaction with either school type or gender. However, HPLC proved more effective in improving students' learning outcome across school types and gender. It was concluded that while all school types had the same effect on learning outcome of science students, there is a need to employ adequate curriculum models that afford learners the opportunity to learn science the way scientists do as well as provide adequate and conducive physical, social and psychological science learning environments for all school types and for both sexes.

Key words: Teaching science, learning cycle model, instructional methods, learning outcome, curriculum model, School type.

INTRODUCTION

One of the outstanding natural endowment of Nigeria as harnessed has the potential of producing high caliber a nation is her human population. This great asset if well human capital necessary for lifting the country into

*Corresponding author. E-mail: c laramoekphd@yahoo.c o.uk, Tel: +2348037438405.

economic, political, and technological prosperity. Many nations such as the United States of America, China, Japan, and even India have utilized their human capital base as a launching pad for national prosperity. For this to happen, human capital development through quality education of the citizens (male and female) was given paramount attention. In Nigeria, about half of her population is made up of the female gender. It means that for any meaningful development of the country, both sexes must contribute their quota equitably in the world of work. Any lopsidedness or tilt may not augur well in the overall interest of the nation. The existence of gender differences in the learning of and achievement in science and Mathematics has been a subject of academic research for many decades and in many countries (Lee and Lockheed, 1990; Omoifo, 1996, 2004; Tambo et al. 2011) such as Zimbabwe and Nigeria. Despite efforts to engender equity, disparity seems to persist in gender participation and achievement in science and science-related jobs and profession especially in developing nations like Nigeria. While indicators have shown a gradual reduction in gender gap in educational access at the primary school in Nigeria (Okogwu, 2009), the same cannot be said of science achievement (Zembar and Blume, 2011), scientific reasoning skill acquisition (Lawson, 2002; Musheno and Lawson, 1999), entry into science related jobs and professions and scientific attitude exhibition.

Studies in the effect of learning environment on students' performance in learning outcome (Hopkin, 2001; Mallam, 1993) revealed significant differences in the achievement of single-sex and co-educational students. Young and Fraser (1994) had earlier stated that most differences in learning outcome previously attributed to gender were actually due to school type. Efforts have also been made in research to identify factors or instructional elements that moderate how girls and boys learn science (Moemeke and Omoifo, 2008). The study shows that girls tend to benefit from curriculum models that emphasize inquiry, hands-on, hypothetico predictive enquiries and those with visual information prompts (Moemeke, 1999) the same way it benefits low ability learners. In the middle of the 1990s, there was a tilt in research opinions towards co- education. Dale (1969) proposed substantial benefits in educating boys and girls in co-educational setups. Top in his reasons is that it provides an avenue for provision of equal opportunities for both sexes. He argued that there was no evidence that coeducation has negative effect on education of girls. However, researches by American Association of University women in the 1990's (Elwood and Gripps, 1999) and Shaw (1995) called for a rethinking of issues of girls' education. They reported that girls in the single sex schools tend to achieve higher in Science and Mathematics even when their laboratories were less well equipped and with less qualified teachers than the boys schools. Different researchers have given reasons for higher achievement of girls in single sex girls' schools to include:

Self-concept which is the total belief that people have about their competence and ability is higher in girls from single sex schools than in girls from coeducation (Kassin et al. 2008; Tully and Jacob, 2010).
Other people's perception affects people's self-concept and as such teachers' communication, attitude and expectation of girls in single sex schools is higher than girls in coeducation. (Tambo et. al, 2011; Kassin et. al., 2008)
Reduced possibility of sex-role stereotyping in single-sex girls school compared to coeducation girls where there is possible high level of fear of success and assuring of leadership roles among girls (Lee and Lockheed, 1990)
Teachers' gender bias that exists latently in coeducational classrooms which promote subject choice bias in favour of boys' dominance, spitefulness and negative competitiveness (Tambo et. al, 2011).

The mediating role of curriculum model in determining achievement of students in schools in the different school types and for different levels of learning outcome is a major focal point of this study.

Statement of the problem

In the recent past, premium has been placed on learning environment as a factor in students' achievement in science. Such environments include both the physical and psychological spheres in which learning occur. An earlier study by Moemeke and Omoifo (2010) has implicated School type in this milieu. They showed that students from single-sex schools performed better than their counterparts from co-educational schools in science. Some other studies have implicated high self-esteem among students from single-sex schools as a possible determinant of achievement since it was found to be higher in single-sex institutions (Cardona, 2011; Lee and Lockheed, 1990). However, in terms of the number of students enrolled for science subjects in schools, students from All-boys schools were found to opt for science subjects more than girls in All-girls schools. The trend was maintained in coeducational schools (Jackson, 2011). Does it then mean that girls are reluctant to opt for science subjects even when taught using the same curriculum model with their male counterpart? The inconclusiveness of research evidence calls for further studies on the effect of school type on achievement in schools. It is likely that other variables such as curriculum model, intelligence, school location, and ethos as well as school management practices interfere with results hence the variation. This study, therefore, asks: To what extent does curriculum model and school type influence male and female students' achievement in science? Is there any learning outcome that is specially preferred by single sex or coeducational schools? Is there any interaction effect of curriculum model and school type on students learning outcome? It is hoped that this study will clear the air on these aspects of science learning research and as such give evidence- based information for further actions towards gender equity in science classrooms as well as towards achievement of the Education for All (EFA) and Millennium Development Goals (MDGs) elements as it concerns gender and achievement of goals of science and technology education.

Research hypotheses

To enable this investigation, the following null hypotheses were stated.

1. There is no significant difference in learning outcome of science students from single sex and coeducational schools based on curriculum pedagotronics.
2. There is no significant difference in the learning outcome of girls from all-girls and their counterparts from coeducational schools in science learning outcome.
3. There is no significant difference in the learning outcome of boys from all-boys and their counterparts from coeducational schools
4. There is no significant interaction effect of curriculum model and school type on learning outcome in science.

METHODOLOGY

The independent variables in the study are curriculum model with three levels (Descriptive learning cycle, Hypthetico-predictive learning cycle and expository approach), school type with three levels (All-boys, All-girls and co-educational) and sex with two levels (Male and female). The dependent variable is learning outcome in three levels (Scientific reasoning skills, Attitude towards science and Achievement in science). The descriptive learning cycle (DLC) as proposed by Karplus and Their (1967) is sequenced approach, which begins with Exploration during which the learner explores the problem of study so as to raise questions which will form a pedestal to the second phase known as term introduction. In this phase, the teacher clarifies and defines concepts, which the exploring students may have come across in the first phase but could not make enough meaning out of. The third phase is the concept application phase during which the teacher and students develop a pattern that enables them to draw a link between concepts within and across disciplines. The HPLC follows the same pattern as the DLC except that there is a conscious effort to lure the learners into two important process skills of science — hypothesizing and predicting which enables them to raise their own hypotheses, make predictions based on their perceived evidence and by so doing reveal their misconceptions/ alternative conceptions about the problem. This exercise provides a platform for fruitful exploration that will follow. The Traditional Expository Approach (TEA) did not involve the learning cycle model. Instead, the approach was teacher-dominated. Students only received facts from the teacher except for few questions that may arise from the students which teacher clarifies.

Nine intact classes of SS2 students from three secondary schools in the three senatorial zones of Delta state Nigeria were used for the study. Each intact class selected from a zone received one of three treatment types for a period of two months (8 weeks). One of the three school types was purposively selected from each zone (All-boys, All-girls and Coeducational schools). A non-equivalent pre-test-post-test control group design without randomization was adopted within the quazi experimental domain. A total of 210 students consisting of 94 coeducational, 47 All-girls and 69 All-boys students participated in the study. Data was collected using three instruments. They are:

1. Test of Scientific Reasoning Skills (TRS) which is a 10- item test of logical reasoning in Biology. The instrument was adapted from Lawson (1992) logic task as used by Norman (1997) and tests for knowledge of relationship, logic of relationships and drawing conclusions based on identified relationships. The reliability coefficient of 0.62 was determined using K-R 21 formula statistically.
2. Test of Attitude towards Biology (TATB). The instrument is a 29item 4-point likert with items framed either positively or negatively and from strongly agree, agree, disagree and strongly disagree. Scoring will be done from 4 to 1 in that order. The reliability coefficient of 0.78 was determined by Crombach alpha.
3. Test of Achievement in biology concepts (TAB). The instrument is a 45-item multiple choice instrument. The items are derived from past West African Senior School Certificate Examination (WASSCE) and National Examinations Council Examination (NECO) past question papers in selected concepts taught during treatment. The topics covered by the test were selected from the SS2 syllabus in Delta state. A reliability coefficient of 0.80 was calculated using K-R formula 21 statistically.

Treatment lasted for 10 weeks. The first and last weeks were used for the administration and collection of pretest and posttest data for the study respectively. The six selected concepts were taught within the remaining eight weeks. Three types of classroom procedures were drawn for the three curriculum models for the six lessons. Thus, a total of eighteen planned lessons were taught (see sample of lesson plan attached as appendix). All lessons were taught by the lead researcher and her partner to ensure uniformity while the science teachers in the selected schools acted as research assistants.

Data management and analysis

Data that resulted from the exercise were coded. The curriculum models (TEA, DLC and HPLC) were coded as 1, 2 and 3 respectively. School type which is a second independent variable in the study was coded 1 for coeducational schools, 2 for all-girls schools, and 3 for all-boys schools. Sex was also coded 1 for males and 2 for females. The dependent variable which is learning outcome consists of three levels (scientific reasoning skills, achievement in Biology concepts and attitude towards biology) was coded as A, B and C respectively.

Table 1. One-way ANOVA repeated measures for learning outcome, and coeducational and single-sex school types.

Hhhuy77675 Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects					
LO	29044.420	1.022	28408.501	186.898	.000*
LO * ST	302.367	1.022	295.747	1.946	.164
Error(LO)	32323.705	212.656	152.000		
(b). Between-subjects effects					
Intercept	1916868.555	1	1916868.555	5971.821	.000*
ST	222.671	1	222.671	.694	.406
Error	66765.000	208	320.986		

$\alpha = .05$ * significant at $p < .05$.

A one-way repeated measure Analysis of Variance (ANOVA) was adopted as statistical tool in this study using learning outcome as repeated measures. Differences found to be significant at 0.05 alpha level was subjected to post hoc analysis to determine the source of the significance.

ANALYSIS AND RESULTS

Hypothesis 1: There is no significant difference in learning outcome of science students from single sex and coeducational schools based on treatment.

A one-way ANOVA with repeated measure on one factor was conducted to determine whether there was a statistical significance in learning outcome between science students from Coeducational and Single-sex schools. The independent variable included a betweensubjects variable, School Type (Coeducational and Single-sex schools), and within-subject variable, repeated measures of Achievement test (AcT), Attitude test (AtT), and Scientific reasoning (SrT). The dependent variable was the test scores performance (in percentages) recorded in each test. Statistical significance was set at an alpha level of .05. The analysis tested if the assumption of Sphericity was violated or not. Mauchly's test indicated that the assumption of sphericity had been violated, X^2 (df=2) =647.57, p<.05, therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.51). Table 1 shows that the learning outcome of science students in AcT (Mean=53.78, SD=.768), AtT (Mean=64.54, SD=.922), and SrT (Mean= 48.07, SD=.925) are significantly different, F (1.02, 212.65) =186.89, p=.000. These results suggest that science students' performance generally varies with respect to the test type; it shows peak performance in AtT (64.54), followed by AcT (53.78) and SrT (48.07).

Furthermore, findings show that there was not a statistically significant interaction in the learning outcome between the Test type (AcT, AtT, or SrT) and School Type (Coeducational or Single), F (1.02, 212.65) =1.94, p = .164. Thus, these results indicate that learning outcome of science students is statistically significant irrespective of the school type. Specifically, learning outcome for science students within Coeducational schools is statistically different; the same trend applies to their counterparts within Single-sex schools (Figure 1). This goes to show that science students' performance in the test types is similar despite the inherent differences in the sex orientation, academic, and administrative structures of the distinct school types (Coeducational or Single-sex schools). Moreover, the findings in Table 2 also show that the average performance between students in Coeducational (Mean=54.87, SD=1.07) and Single-sex (Mean=56.03, SD=.96) schools was not significantly different, F (1, 208)=0.694, p=.406. Therefore, the average performance of science students in Co-educational schools is similar to that of their counterparts in Single sex schools. However, single sex schools maintained a slight edge over their coeducational counterparts in scientific reasoning as is seen in Figure 1. To determine if there is any difference in the learning outcome of the overall sample from single-sex and co-educational school due to curriculum model applied, data is presented in Table 3.

A one-way ANOVA with repeated measure was conducted to determine whether the adoption of the Curriculum Models (CM) significantly affected the Learning Outcome (LO) of science students from Coeducational and Single-sex schools. In other words, the analysis sought to find out whether the performance of science students in Achievement test (AcT), Attitude test (AtT), and Scientific reasoning test (SrT) was influenced by the type of CM adopted. The independent variable CM was adopted – it was measured at three levels [Expository Approach (TEA), Descriptive Learning Cycle (DLC), and Hypthetico-Predictive Learning Cycle (HPLC)] - while the dependent variable was the performance scores (measured in percentages) for each test. Statistical significance was set at 0.05 level of significance. Mauchly's test indicated that the assumption of sphericity had been violated, X^2 (df=2) =13.34, p<.05, therefore degrees of freedom were corrected using GreenhouseGeisser estimates of sphericity (E=.873). Table 3 shows that the LO of all science students was statistically significant given F(1.02, 210.83)=178.345 and p<0.05; this result suggests that the average score of the science students in (at least) one of the three test is significantly different from the rest. In essence, the average performance of students in the given tests i.e AcT, AtT, and SrT were not similar. This difference

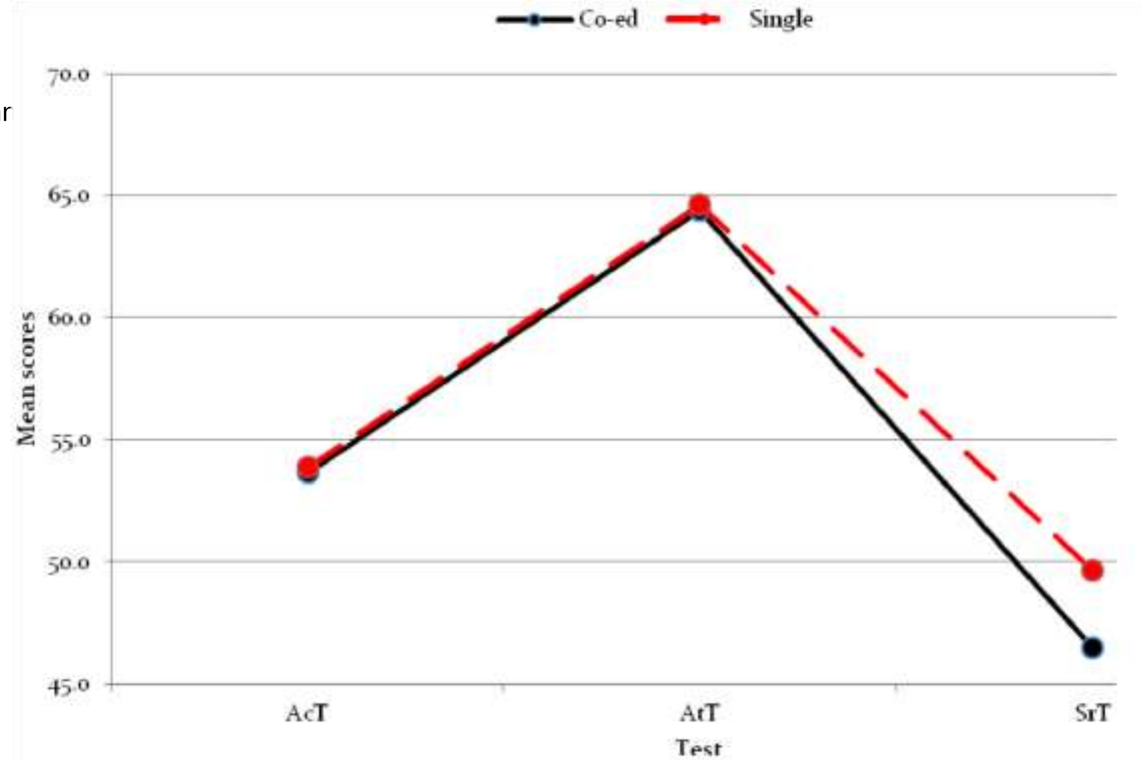

Figure 1. Graphical representation of subjects' performance in the three tests by school type.

Table 2. Mean scores for learning outcome, and single-sex and coeducational school types.

Variables		Mean	Std. Dev	95% CI	
				Lower	Upper
Learning outcome					
AcT		53.78	0.77	52.27	55.30
AtT		64.54	0.92	62.72	66.36
SrT		48.07	0.92	46.25	49.89
School type					
Co-ed	AcT	53.688	1.141	51.438	55.938
	AtT	64.426	1.370	61.725	67.126
	SrT	46.489	1.374	43.780	49.199
Single sex	AcT	53.879	1.028	51.854	55.905
	AtT	64.655	1.233	62.224	67.086
	SrT	49.655	1.237	47.216	52.094

is further highlighted in Table 4 which shows that students' performance in AtT (mean score=64.260) was significantly better than AcT (mean score=53.550) and SrT (mean score=48.101), whereas their performance in AcT (mean score=53.550) was significantly better than SrT (mean score=48.101). Thus, from a generic point of view, science students (a combination of Coeducational and Single-sex schools) performed best in the AtT test, and least in SrT test.

Furthermore results in Table 3 (LO*CM) shows that the CM effect on LO of all science students was statistically not-significant given $F(2.04, 210.83)=0.688$ and $p>0.05$; this suggests that the order of performance of science students in the three test (AcT, AtT, and SrT) was not significantly influenced by the CM adopted. Specifically, this implies that irrespective of the nature/kind of CM adopted (whether TEA, DLC, or HPLC), the order of performances in the respective tests was still the same. Emphasis on this outcome is evidenced in Table 4 for TEA, the students performed best in AtT (mean score= 48.056) and least in SrT (mean score=43.333); for DLC,

Table 3. One-way ANOVA repeated measures for learning outcome of science students of Coeducational and Single-sex schools based on Curriculum model.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	27923.929	1.02	27417.167	178.345	.000
	LO * CM	215.498	2.04	105.794	.688	.506
	Error(LO)	32410.575	210.83	153.731		
(b). Between-subjects effects						
	Intercept	1895418.677	1	1895418.677	7101.732	.000
	CM	11740.351	2	5870.176	21.994	.000
	Error	55247.320	207	266.895		

α= .05; * significant at p< .05.

Table 4. Mean scores and standard deviations of learning outcome of coeducational and single-sex science students [based on curriculum model adopted].

Variables		Mean	Std. Dev	95% CI		Group
				Lower	Upper	
(a) *Learning outcome*						
AcT		53.550	.717	52.137	54.963	B
AtT		64.260	.860	62.564	65.956	A
SrT		48.101	.892	46.341	49.860	C
(b) *Learning outcome based on curriculum model adopted*						
TEA	AcT	48.056	1.330	45.433	50.678	B
	AtT	57.667	1.596	54.520	60.813	A
	SrT	43.333	1.656	40.069	46.598	C
DLC	AcT	54.065	1.138	51.822	56.308	B
	AtT	64.878	1.365	62.186	67.570	A
	SrT	47.439	1.416	44.647	50.231	C
HPLC	AcT	58.529	1.249	56.066	60.993	B
	AtT	70.235	1.499	67.280	73.191	A
	SrT	53.529	1.555	50.463	56.596	C
(c) *Curriculum Model*						
TEA		49.685	1.218	47.285	52.086	C
DLC		55.461	1.042	53.407	57.514	B
HPLC		60.765	1.144	58.510	63.020	A

the students performed best in AtT (mean score=64.878) and least in SrT (mean score=47.439); for HPLC, the students performed best in AtT (mean score=70.235) and least in SrT (mean score=53.529). Therefore the curriculum model did not significantly affect how the students performed in the tests. However, based on Table 3, the result shows that the performance of science students differed significantly based on the CM adopted, it yielded $F(1.02, 210.83)=178.345$ and $p<0.05$; this result indicates that students' overall LO score (cumulative score for AcT, AtT, and SrT) is significantly different for (at least) one of the CM adopted. This difference is further highlighted in Table 4 which shows the outcome of a Bonferroni post hoc test. The post-hoc test shows that students' overall LO score for HPLC (mean score=60.765) was significantly higher than DLC (mean score=55.461) and TEA (mean score=49.685), whereas their overall LO score for DLC (mean score=55.461) was significantly higher than that of TEA (mean score=49.685). Thus, science students (a combination of Coeducational and Single-sex schools) had the best LO score when HPLC model was applied, and least LO score when TEA model was applied. In concluding the analysis, Curriculum model adopted will not significantly influence the learning outcome of science students from Coeducational and Single-sex schools.

Hypothesis 2*: There is no significant difference in the learning outcome of girls from All-girls and their counterparts in coeducational schools.*

A one-way ANOVA with repeated measure was conducted to determine whether there was a statistical significance in learning outcome between female science students from Coeducational and Girls-only schools. Mauchly's test indicated that the assumption of sphericity had been violated, X^2 (df=2) =13.34, p<.05, therefore, degrees of freedom were corrected using Greenhouse Geisser estimates of sphericity (E=.873). Table 5 shows that the learning outcome of all female science students are significantly different, F (1.75, 150.18) =57.684, p=.000. In particular, they performed similarly in AcT (Mean=60.95, SD=1.523) and AtT (Mean=60.37, SD= 1.355), whereas they performed significantly low in SrT (Mean=45.94, SD=1.453). As the results imply, all female science students are intellectually stronger in AcT and AtT than SrT.

Furthermore, findings show that there was not a statistically significant interaction in the learning outcome between the Test type (AcT, AtT, or SrT) and School Type (Female science students from Coeducational or Girls-only schools), F (1.75,150.18) =1.16, p = .311. Thus, these results indicate that learning outcome of female science students is statistically significant in both school types. Specifically, female science students within Coeducational schools performed similarly in AcT (Mean=60.19, SD=2.225) and AtT (Mean=58.37, SD= 1.981) but significantly low in SrT (Mean=46.34, SD=2.124); invariably implying that they are intellectually stronger in AcT and AtT than SrT. This same trend applies to their counterparts within Girls-only schools; similar performance in AcT (Mean=61.70, SD=2.079) and AtT (Mean=62.38, SD=1.850), but significantly low in SrT (Mean=45.53, SD=1.984); see Table 4. However, a closer look at the performances shows that those from Girlsonly schools performed marginally higher in AcT and AtT, than their counterparts in Coeducational schools (Figure 2).

Moreover, the findings in Table 6 show that the average performance between female science students in Coeducational (Mean=54.97, SD=1.64) and Girls-only (Mean=56.54, SD=1.53) schools was not significantly different, F (1, 86)=0.492, p=.485. Therefore, the average performance of female science students in Coeducational schools follows the same pattern as that of their counterparts in Girls-only schools except that girl in single sex schools registered higher mean scores in AcT and AtT (Figure 2). A one-way ANOVA with repeated measure was conducted to determine whether the adoption of the Curriculum Models (CM) significantly affected the Learning Outcome (LO) of female science students from Coeducational and Girls-only schools. In other words, the analysis sought to find out whether the performance of female science students in Achievement test (AcT), Attitude test (AtT), and Scientific reasoning test (SrT) was influenced by the type of CM adopted. The independent variable was the CM adopted – it was measured at three levels [Expository Approach (TEA), Descriptive Learning Cycle (DLC), and Hypthetico-Predictive Learning Cycle (HPLC)] - while the dependent variable was the performance scores (measured in percentages) for each test. Statistical significance was set at 0.05 level of significance. Mauchly's test indicated that the assumption of sphericity had been violated, given X^2 (df=2) =12.18, p<.05, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.881). Table 7 shows that the LO of female science students was statistically significant given F(1.76, 149.79)=61.343 and p<0.05; this result suggests that the average score of the female science students in (at least) one of the three test is significantly different from the rest.

In essence, the average performance of female students in the given tests that is, AcT, AtT, and SrT were not similar. This difference is further highlighted in Table 4 which shows that female students' performances in AtT (mean score=64.260) and AcT (mean score=53.550) was not significantly different, yet their scores in both tests was significantly higher than SrT (mean score=48.101). This implies that female science students performed best in the AtT and AcT tests, and least in SrT test.

Furthermore, results in Table 7 that is, LO*CM, shows that the CM effect on LO of female science students was statistically not-significant given F(3.52, 149.79)=2.066 and p>0.05; this suggests that the order of performance of female science students in the three test (AcT, AtT, and SrT) was not significantly influenced by the CM adopted. As such, irrespective of the type of CM adopted (whether TEA, DLC or HPLC), the result indicates that the order of performances in the respective tests was still the same. Emphasis on this outcome is detailed in Table 4: for TEA, the female students performed similarly in AtT (mean score=54.19) and AcT (mean score=53.81), and performed least in SrT (mean score=39.35); for DLC, the female students performed similarly in AtT (mean score= 56.98) and AcT (mean score=59.73), and performed least in SrT (mean score=47.67); for HPLC, the female students performed similarly in AtT (mean score=70.67) and AcT (mean score=71.68), and performed least in SrT (mean score=51.48). Therefore, the curriculum model did not significantly affect how the students performed in the tests.

However, based on Table 8, the result shows that the performance of female science students differed significantly based on the CM adopted, it yielded F(2, 85)=24.92 and p<0.05; this result indicates that female students' overall LO score (cumulative score for AcT, AtT, and SrT) was significantly different for (at least) one of the CM

Table 5. One-way ANOVA repeated measures for learning outcome, and females in coeducational and girls-only school types.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	12675.583	1.746	7258.568	57.684	.000*
	LO * ST	254.704	1.746	145.854	1.159	.311
	Error(LO)	18897.730	150.181	125.833		
(b). Between-subjects effects						
	Intercept	816810.664	1	816810.664	2480.765	.000
	ST	161.917	1	161.917	.492	.485
	Error	28316.149	86	329.258		

α= .05 * significant at p< .05.

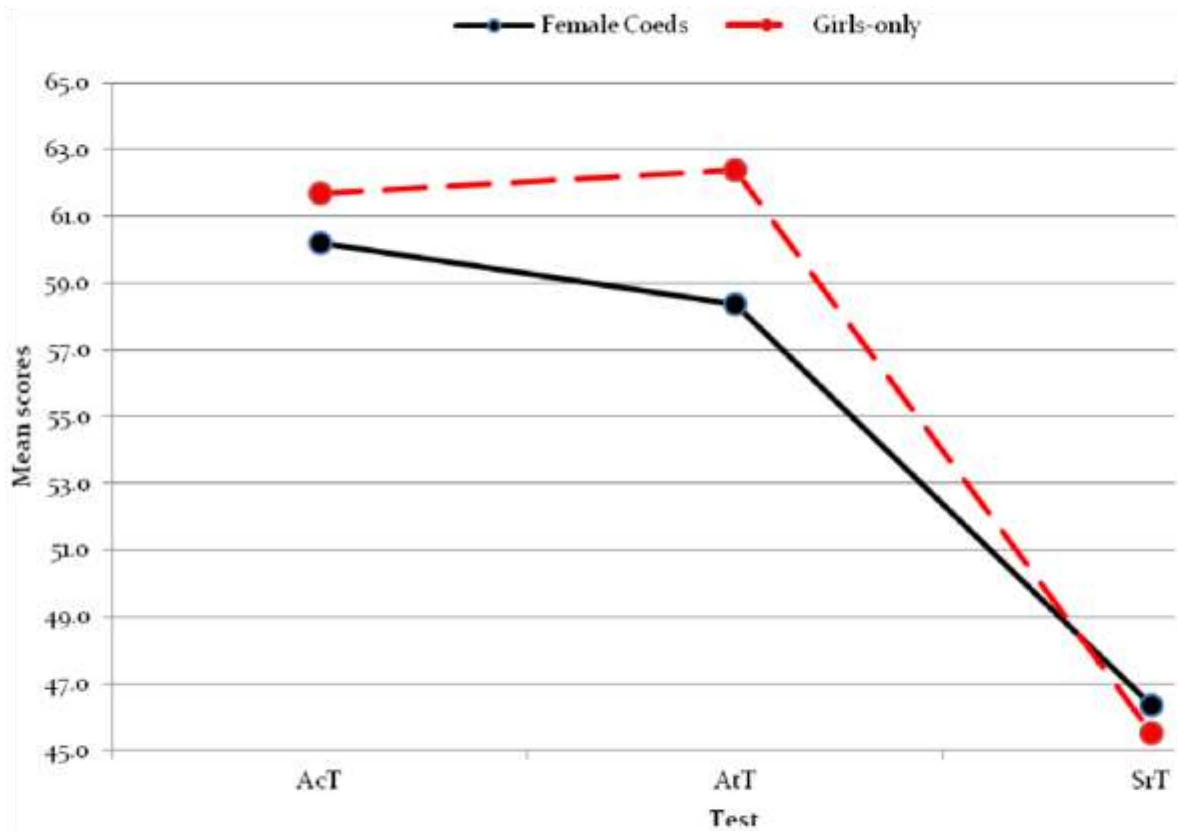

Figure 2. Graphical representation of performance of girls in the three tests from single-sex and Co-educational schools.

adopted. This difference is further highlighted in Table 4 which shows the outcome of a Bonferroni post-hoc test. The post-hoc test shows that female students' overall LO score for HPLC (mean score=64.61) was significantly higher than DLC (mean score=54.79) and TEA (mean score=49.12), whereas their overall LO score for DLC (mean score=54.79) was significantly higher than that of TEA (mean score=49.12). Thus, female science students had the best LO score when HPLC model was applied, and least LO score when TEA model was applied.

***Hypothesis 3**: There is no significant difference in the learning outcome of boys from all-boys schools and their counterparts from Coeducational schools.*

Table 6. Mean scores for learning outcome, and females in coeducational and Girls-only school types.

		Mean	Std. Dev	95% CI	
				Lower	Upper
Learning Outcome					
AcT		60.949	1.523	57.922	63.975
AtT		60.375	1.355	57.680	63.069
SrT		45.937	1.453	43.047	48.826
School Type					
Co-ed	AcT	60.195	2.225	55.771	64.619
	AtT	58.368	1.981	54.430	62.307
	SrT	46.341	2.124	42.118	50.565
Girls-only	AcT	61.702	2.079	57.570	65.834
	AtT	62.381	1.850	58.702	66.059
	SrT	45.532	1.984	41.588	49.476

Table 7. One-way ANOVA repeated measures for Learning outcome of female science students in Coeducational and Girls-only schools based on Curriculum model.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(***a). Within-subjects effects***						
	LO	13181.131	1.762	7479.787	61.343	.000
	LO * CM	887.876	3.524	251.918	2.066	.097
	Error(LO)	18264.558	149.790	121.935		
(b). ***Between-subjects effects***						
	Intercept	830185.055	1	830185.055	3930.895	.000
	CM	10526.498	2	5263.249	24.921	.000
	Error	17951.568	85	211.195		

α= .05; * significant at p< .05.

A one-way ANOVA with repeated measure was conducted to determine whether there was a statistical significance in learning outcome between male science students from Coeducational and Boys-only schools. Mauchly's test indicated that the assumption of sphericity was not violated, X^2 (df=2) =2.74, p>.05, hence the analysis results are based on the assumption that there is homogeneity across the students' performance scores. Table 9 shows that the learning outcome of all male science students are significantly different, F (2, 240) =100.365, p=.000. This implies that all male science students generally performed similarly in AcT (Mean= 67.18, SD=1.094) and AtT (Mean=64.59, SD=1.163), whereas they performed significantly low in SrT (Mean=49.53, SD=1.169). As the results imply, male science students are intellectually stronger in AcT and AtT than SrT.

Furthermore, findings show that there was a statistically significant interaction in the learning outcome between the Test type (AcT, AtT, or SrT) and School Type (Male science students from Coeducational or Boys-only schools), F (2, 240) =6.77, p = .001. Thus, these results indicate that the statistical significance in learning outcome of male science students is not similar in both school types. Specifically, male science students within Coeducational schools performed similarly in AcT (Mean=67.69, SD=1.646) and AtT (Mean=66.46, SD= 1.749) but significantly low in SrT (Mean=46.60, SD=1.759); invariably implying that they are intellectually stronger in AcT and AtT than SrT. However, this same trend does not equally apply to their counterparts within Boys-only schools; a marginal statistical significance was observed between AcT (Mean=66.67, SD=1.443) and AtT (Mean=62.72, SD=1.533), and a significantly low performance in SrT (Mean=52.46, SD=1.541). Thus, male science students in Boys-only schools have distinct learning outcomes in each test type, while their coeducational counterparts have similar learning outcomes

Table 8. Mean scores and standard deviations of learning outcome of female coeducational and Girls-only science students [based on Curriculum model].

Variables		Mean	Std. Dev	95% CI		Group
				Lower	Upper	
(a) *Learning Outcome*						
AcT		61.402	1.338	58.743	64.062	A
AtT		60.954	1.112	58.743	63.164	A
SrT		46.168	1.354	43.476	48.860	B
(b) *Learning outcome based on Curriculum Model adopted*						
TEA	AcT	53.806	2.250	49.333	58.280	A
	AtT	54.199	1.870	50.481	57.917	A
	SrT	39.355	2.277	34.827	43.883	B
DLC	AcT	59.733	2.287	55.186	64.280	A
	AtT	56.983	1.901	53.203	60.762	A
	SrT	47.667	2.315	43.064	52.269	B
HPLC	AcT	70.667	2.411	65.874	75.460	A
	AtT	71.679	2.004	67.695	75.664	A
	SrT	51.481	2.440	46.630	56.333	B
(c) *Curriculum Model*						
TEA		49.120	1.507	46.124	52.116	C
DLC		54.794	1.532	51.748	57.840	B
HPLC		64.609	1.615	61.399	67.820	A

Table 9. One-way ANOVA repeated measures for learning outcome, and **males** in coeducational and Boys-only school types.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	21777.147	2	10888.573	100.365	.000*
	LO * ST	1469.168	2	734.584	6.771	.001*
	Error(LO)	26037.520	240	108.490		
(b). Between-subjects effects						
	Intercept	1313793.960	1	1313793.960	5200.929	.000*
	ST	11.796	1	11.796	.047	.829
	Error	30312.904	120	252.608		

α= .05 * significant at p< .05.

in AcT and AtT and distinct for SrT (As shown in Figure 3). However, the findings in Table 10 show that the average learning outcome between male science students in Coeducational (Mean=60.25, SD=1.26) and Boys-only (Mean=60.62, SD=1.11) schools was not significantly different, F (1, 120)=0.047, p=.829. Therefore, the average performance of male science students in Coeducational schools is similar to that of the counterparts in Boys-only schools.

A one-way ANOVA with repeated measure was conducted to determine whether the adoption of the Curriculum Models (CM) significantly affected the LO of male science students from Coeducational and Boys-only schools. In other words, the analysis sought to find out whether the performance of female science students in Achievement test (AcT), Attitude test (AtT), and Scientific reasoning test (SrT) was influenced by the type of CM adopted. The independent variable was the CM adopted – it was measured at three levels [Expository Approach (TEA), Descriptive Learning Cycle (DLC), and HyptheticoPredictive Learning Cycle (HPLC)] - while thedependent variable was the performance scores (measured in percentages) for each test. Statistical significance was set at 0.05 level of significance. Mauchly's test indicated that the assumption of sphericity had been violated, given X^2 (df=2) =8.02, p<.05, therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.938).

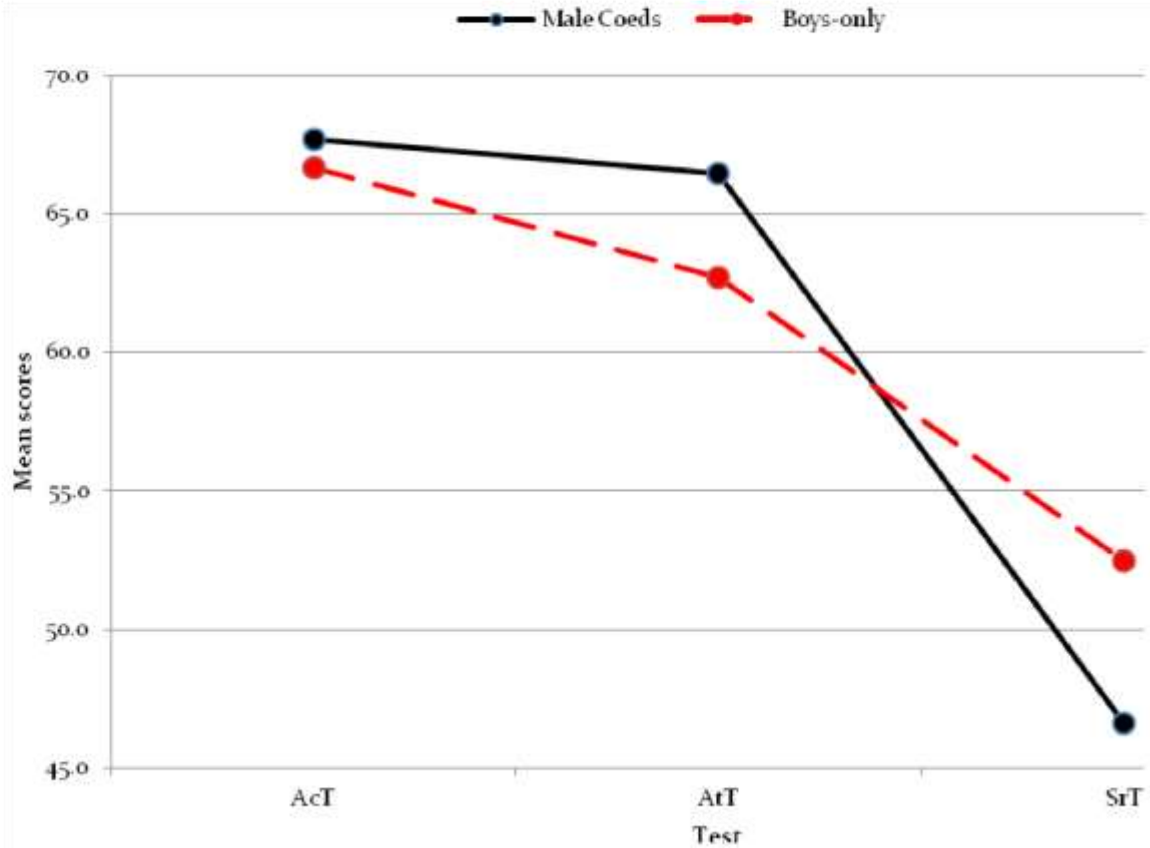

Figure 3. Graphical representation of the performance of boys from boys-only and coeducational schools in the three tests.

Table 10. Mean scores for Learning outcome, and Males in Coeducational and Boys-only school types.

Variables		Mean	Std. Dev	95% CI Lower	95% CI Upper
Learning Outcome					
AcT		67.18	1.09	65.02	69.35
AtT		64.59	1.16	62.29	66.89
SrT		49.53	1.17	47.22	51.85
School Type					
Co-ed	AcT	67.698	1.646	64.439	70.957
	AtT	66.461	1.749	62.998	69.923
	SrT	46.604	1.759	43.122	50.086
Boys-only	AcT	66.667	1.443	63.810	69.523
	AtT	62.719	1.533	59.684	65.753
	SrT	52.464	1.541	49.412	55.515

Table 11 shows that the LO of male science students the male science students in (at least) one of the three was statistically significant given F(1.88, 223.32)=87.109 test is significantly different from the rest. In essence, the and p<0.05; this result indicates that the average score of average performance of male students in the given tests

Table 11. One-way ANOVA repeated measures for Learning outcome of male science students in Coeducational and Boys-only schools based on Curriculum model.

Sections	Source	Sum of Squares	df	Mean Square	F	Sig.
(a). Within-subjects effects						
	LO	18022.782	1.877	9603.638	87.109	.000
	LO * CM	2885.650	3.753	768.825	6.974	.000
	Error(LO)	24621.038	223.323	110.249		
(b). Between-subjects effects						
	Intercept	1243838.262	1	1243838.262	6754.836	.000
	CM	8411.991	2	4205.996	22.841	.000
	Error	21912.709	119	184.140		

α= .05* significant at p< .05.

Table 12. Mean scores and standard deviations of learning outcome of male Coeducational and Girls-only science stu [based on Curriculum model adopted].

Variables	Mean	Std. Dev	95% CI Lower	95% CI Upper	Group
(a) Learning Outcome					
AcT	66.530	1.083	64.386	68.675	A
AtT	63.498	.907	61.703	65.293	B
SrT	49.924	1.183	47.582	52.266	C

Table 13. Two-way ANOVA repeated measures for curriculum model and school type on learning outcome in science.

Source	Sum of Squares	Df	Mean Square	F	Sig.
(a). Within-subjects effects					
LO	29527.269	1.830	16134.616	141.822	.000
LO * Trt	1768.378	3.660	483.148	4.247	.003
LO * ST	1247.479	3.660	340.831	2.996	.022
LO * ST*CM	1712.281	7.320	233.911	2.056	.045
Error(LO)	41848.096	367.841	113.767		
(b). Between-subjects effects					
Intercept	1941616.663	1	1941616.663	9966.734	.000
CM	18837.870	2	9418.935	48.349	.000
ST	1687.677	2	843.839	4.332	.014
ST*CM	1702.478	4	425.619	2.185	.072
Error	39156.753	201	194.810		

(b) Learning outcome based on Curriculum Model adopted						
TEA	AcT	61.793	2.159	57.518	66.068	A
	AtT	53.419	1.807	49.840	56.997	B
	SrT	47.586	2.357	42.918	52.254	B
DLC	AcT	67.846	1.612	64.654	71.039	A
	AtT	61.887	1.350	59.214	64.559	B
	SrT	47.308	1.760	43.822	50.794	C
HPLC	AcT	69.951	1.816	66.356	73.547	B
	AtT	75.189	1.520	72.180	78.199	A
	SrT	54.878	1.983	50.952	58.804	C
(c) Curriculum Model						
TEA		54.266	1.455	51.385	57.147	C
DLC		59.013	1.086	56.862	61.165	B
HPLC		66.673	1.224	64.250	69.096	A

α= .05* significant at p< .05.

that is, AcT, AtT and SrT were not similar. This difference is further highlighted in Table 6 which shows that male students' performances in AcT (mean score=66.53) was significantly higher than AtT (mean score=63.49) and SrT (mean score=49.92), whereas their performance in AtT (mean score=63.49) was significantly higher than SrT (mean score=49.92). This implies that male science students performed best in the AcT tests, and least in SrT test. Furthermore, results in Table 11 that is, LO*CM, shows that the CM effect on LO of male science students was statistically significant given F(3.75, 223.32)=6.974 and $p<0.05$; this indicates that the order of performance of male science students in the three test (AcT, AtT, and SrT) was significantly influenced by the CM adopted. As such, the result indicates that the order of performances in the respective tests varied based on the CM adopted. Emphasis on this outcome is detailed in Table 12: for TEA, the male students performed best in AcT (mean score=61.79) but similarly in AtT (mean score=53.42) and SrT (mean score=47.59); for DLC, the male students performed best in AcT (mean score=67.85) than AtT (mean score=61.89) and SrT (mean score=47.31); for HPLC, the male students performed best in AtT (mean score=75.19) than AcT (mean score=69.95) and SrT (mean score=54.88). Therefore, the curriculum model significantly affected how the students performed in the tests.

However, based on Table 13, the result shows that the overall performance of male science students differed significantly based on the CM adopted, it yielded F(2, 119)= 22.84 and p<0.05; this result indicates that male students' overall LO score (cumulative score for AcT, AtT, and SrT) was significantly different for (at least) one of the CM adopted. This difference is further highlighted in Table 11(b) which shows the outcome of a Bonferroni post-hoc test. The post-hoc test shows that male students' overall LO score for HPLC (mean score=66.67) was significantly higher than DLC (mean score=59.01) and TEA (mean score=54.27), whereas their overall LO score for DLC (mean score=59.01) was significantly higher than that of TEA (mean score=54.27). Thus, male science students had the best LO score when HPLC model was applied, and least LO score when TEA model was applied.

Hypothesis 4*: There is no significant interaction effect of curriculum model and school type on learning outcome in science.*

A two-way ANOVA with repeated measure was conducted to determine whether there was a significant interaction effect between curriculum model and school type on learning outcome of science students. Mauchly's test indicated that the assumption of sphericity was not violated, X^2 (df=2) =19.492, p<.05, therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (E=.873). The analysis output shows that the learning outcome of science students are significantly different, F (1.83, 367.84)=141.82, p=.000. This implies that while all science students generally had similar high outcome in AcT (Mean=64.05, SD=.882) and AtT (Mean=62.48, SD=.730), they performed significantly low in SrT (Mean=48.09, SD=.894). As the results imply, science students are intellectually stronger in AcT and AtT than SrT.

Moreover, findings in Table (14) show that the overall learning outcome of science students is significantly different across the Treatment types applied (i.e TEA, DLC, and HPLC), F (2, 201) =48.35, p = .000. Hence these results indicate that the learning outcome is significantly different for at least one treatment type; specifically, learning outcome was found to be similar between TEA (Mean=51.89, SD=1.058) and DLC (Mean=56.70, SD=.948), but was significantly high for HPLC (Mean=66.02, SD=1.021) treatment. This finding suggests that while TEA and DLC curriculum models appear to have relatively low learning outcome effect among science students generally, its effect was worse for Coed students and girls (Figure 4). The HPLC model on the other hand seemed to be a more beneficial and effective approach to improving learning outcome of all groups especially for girls. The improvement in the outcome scores of the Coed group is a pointer to that effect. Table (14) also shows that learning outcome is significantly different across the School types (that is, Coeducational, Girls-only, and Boys-only), F (2, 201) =4.332, p = .014. The results indicate that learning outcome is significantly different for at least one school type: learning outcome for Coeducational (Mean=57.29, SD=.843) and Girls-only (Mean=56.73, SD=1.176) science students was found to be similar, whereas their counterparts from Boys-only schools (Mean=60.59,

Table 14. Mean scores for curriculum model, school type and learning outcome in science.

Variables	Mean	Std. Dev	95% CI	
			Lower	Upper

Learning Outcome				
AcT	64.051	.882	62.312	65.789
AtT	62.476	.730	61.036	63.915
SrT	48.097	.894	46.334	49.861
Treatment (CM)				
TEA	51.899	1.058	49.813	53.985
DLC	56.702	.948	54.832	58.571
HPLC	66.023	1.021	64.010	68.036
School Type				
Co-ed	57.297	.843	55.634	58.960
Co-ed	56.728	1.176	54.409	59.047
Single	60.598	.983	58.661	62.536

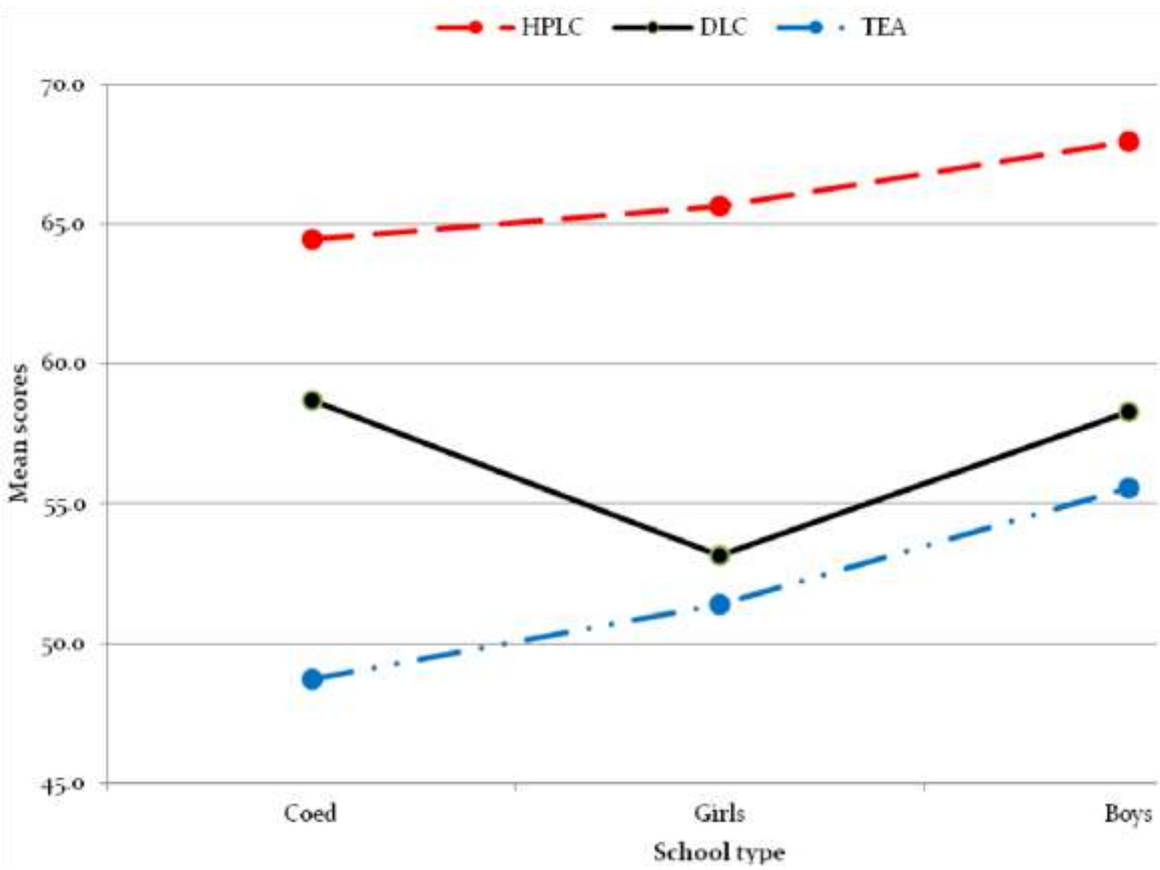

Figure 4. Graphical representation of interaction of school type and curriculum model on learning outcome.

SD=.983) have a significantly higher learning outcome in between School type and Treatment on learning outcome, all curriculum models (Figure 4). Furthermore, Table F (4, 201) =2.185, p = .072. The results indicate that the 14(b) shows that there is no significant interaction effect significant difference in learning outcome appears to be similar across different treatment types for each school type, and vice-versa (As shown in Figure 4).

superior performance in scientific reasoning (As shown in Figure 1).

Discussion of results

The study centered on the effect of curriculum model (treatment type) and school type on science students learning outcome. One of the results of the study is that there is a significant difference in the learning outcome of science students (mean = AcT= 53.69, ArT =64.54 and SrT=48.07 respectively). Science students in the study recorded highest mean scores in attitude (mean=53.69) and least in scientific reasoning (mean 48.07).The high attitude outcome is in line with the Bishop (1980), Lawson (1995) and Moemeke (2010). The high attitude outcome of the subjects in the study may be attributed to method of instruction and social and interactive variables associated with the instructional practices in the study.

The study recorded an improvement in the achievement of the subjects in the same school type over their scientific reasoning skills. The improved achievement in science conforms to explanation given by Simpson and Oliver (1990) and Hegarty-Hazel (1990) that attitude towards science influence and induce achievement but not vice vasa. It means that if instructional practices successfully boast science students' attitude towards doing science a possible increase in the achievement outcome might result. The significant difference in the learning outcome in all school types indicated that school type variables operate similarly respective of ethos characteristics or sex-orientation of the schools. Another finding of the study also showed similarity in the performance of science students in the different levels of learning outcome in the Coeducational and single-sex schools. Though the single-sex schools showed slight superiority in learning outcome (mean=56.03) over the Coeducational subjects (Mean=54.87), the difference was not statistically significant. This is at variance with the previous study reported by Bishop (1980) and Moemeke and Omoifo (2010) whose studies reported statistically significant differences in favour of single-sex school subjects. This may be unconnected with the recent reorganization of school ownership in Delta State, Nigeria (the study area) in which most single-sex schools were handed over to missionary owners and a consequent mass exodus of former single-sex school students to Coeducational Government owned schools. This prevailing situation may have cushioned the effect of school type since the transfer students still bear their foundation ethos back ground. This calls for regular intermittent studies of this sort to monitor variations in the learning outcome of the different school-types. However, the relatively higher scientific reasoning score of subjects of single-sex schools (49.66) over coeducational counterparts (46.49) is indicative of their

The study also compared statistically the performance of girls in single-sex schools and their counterparts in Coeducational schools along the three levels of learning outcome. A significant difference was found in their performance in the three outcomes in both schools types. Girls in both school types performed evenly in attitude and achievement in science concepts and lowest in scientific reasoning skills. The result of this study is at variance with that reported by Mallam (1993), Granleese and Joseph (1993), Young and Fraser (1994), Lee and Lockhead (1990), Lee and Marks (1990) and Hopkins (2001).The studies referred to above advanced reason for the performance to include:

1. Reduced opposite sex interaction and distractions 2. Increase commitment to academics as a consequence of reduced distraction
3. Removing feelings of inferiority and inhibition in Coeducational girls and
4. High self-esteem in All- girls subjects among others.

This present study result conforms to Brustaert and Brake (1994) who did not find any such difference. It is pertinent to note here that the present result suggests some cognitive or intellectual connection between the performance of girls and the type of outcome which they prefer. The low scientific reasoning performance recorded in both school types suggests that there is need to focus deliberate instructional practices on helping girls generally to improve their reasoning skill and consequently decision making ability. Moemeke and Omoifo (2010) had earlier recommended that instructional strategies which reduce mental tasks while solving problem are more beneficial to girls as it is to low ability learners. The many steps in organizing mental thought processes towards reasoning scientifically in a problem situation is likely to have posed serious problems during scientific reasoning and responsible for the low outcome level. However, worthy of note is the marginal superior mean of girls from girls-only schools in achievement (61.70) and Attitude (62.38) over girls from coeducation schools (60.1 and 58.37) respectively. These differences are however not significant at the 0.05 alpha level used in this study.

This trend is also maintained by boys from boys-only and their counterparts in coeducational schools (AcT > ArT > SrT). In comparison, the higher test scores of boys in coeducational schools in achievement and attitude over the boys from boys-only schools may be psychological and linked to natural tendency for boys to dominate science classrooms especially in culturally influences classrooms such as those in Nigerian in which males tend to be emotionally more balanced than females and the need to boost masculine ego. In the area of scientific reasoning, boys from All-boys schools showed superiority (As shown Figure 3) indicating their superior thinking sequences and possible better utilization of problem solving repertoires. The non- significance of the differences in the performance of Boys from Boys- only school and those from coeducational schools shows similarity in their performance patterns. This may also be linked to the recent administrative reorganization of schools that resulted in mass movement of students from single-sex schools to Government-owned coeducational schools due to introduction of fees in such single-sex schools taken over by their previous missionary owners.

The respect to hypothesis four, result showed that while learning outcome varied similarly according to types within each treatment group and school- type, the HPLC produced significantly highest overall outcome across all measures in all school types. It means that the HPLC was a more potent curriculum model for boosting performance in all outcome measures. This result in similar to Douglas and Kahle (1977), Hurst and Milkent (1996), Lavoie (1999) and Lawson et al (2000) in which HPLC model produced better outcome in all measures across all ability levels and all school types. This potency is linked to certain attributes of the HPLC Model such as helping learners test their knowledge claims, reducing cognitive dissonance associated with multiple science views, helping learners develop adequate logical patterns as well as exposing their misconception or alternative conceptions for possible remediation. The deliberate emphasizing of predictive exercises prior to the learning cycle phase must have provided the impetus for better learning. Though the DLC was found to produce better outcome than the TEA (As shown in Figure 4), the difference was not statistically significant. This result is similar to previous studies by Westbrook and Rogers (1994).

SUMMARY

The study focused on identifying differences in learning outcome across the different measures (achievement in science concepts, attitude towards science and scientific reason) in the different school types (single sex and coeducational) taught with the Learning Cycle Curriculum Model (DLC and HPLC) and the Traditional expository approach (TEA). 210 SS ll students participated in the study in the current 2012/2013 academic session. Four null hypotheses were tested. The study lasted for ten weeks. Sample (intact classes) was drawn from the Coeducational, Boys-only and Girls- only schools. Data generated were analyzed using the one- way repeated measures ANOVA and two-way repeated measures ANOVA respectively. Result showed similarity in learning outcome patterns of subject from all school- types and in all measures but different in terms of magnitude with Attitude towards science (AtT) most enhanced followed by Achievement in science concepts (AcT). There was no significant variation between each school-types. However single sex school/subjects proved superior in scientific reasoning when compared with their counterparts from Coeducational schools for both sexes.

CONCLUSION

Based on the finding of this study the following conclusions were made.

School type variable has no significant effect on science students learning outcome. The pattern of performance in the difference learning outcome measures is the same in all school types.

Among the entire sample, students performed most in attitude towards science, followed by achievement in science concepts and least in scientific reasoning skill with students of single-sex schools having marginal superiority in scientific reason skill.

Within each school type, the performance in learning outcome of students of the same sex conform to the same pattern but with significantly better performance recorded by students of Girls- only schools in Attitude towards science and Achievement but not in scientific reasoning skill.

Males from coeducational schools showed better performance in Achievement in science concepts and Attitude towards science than their counterparts in single sex (boys-only) schools. However, the boys-only subjects were significantly better than their counterparts in scientific reasoning skill exhibition.

On a similar note, science students had significantly different overall LO score based on the CM adopted. Specifically, the best overall LO score was obtained when HPLC model was applied, while the least overall LO score was obtained when TEA model was applied. This could imply that HPLC model is the best model (of the three CM) for LO. It however did not discriminate among sexes.

RECOMMENDATION

Based on the findings of this study earlier highlighted, it is hereby recommended that:

All schools should be provided with adequate and enabling learning environment conducive for learning. These include physical, Psychological and social environments since there seem to be no disparity in learning outcome based on school types.

Teachers and counselors in secondary schools should guide coeducational girls adequately to improve their self-concept, confidence in their ability to learn science and on how to reduce the distractive presence of the opposite sex so as to compete favorably with the opposite sex in science.

The Government should set up some single sex school to be administered and managed by government. The present situation in which all the single- sex secondary schools have been given back to their missionary initial owners may have accounted for some extraneous results in this study.

Teachers in secondary schools should adopt instructional/curriculum model that emphasize the acquisition of scientific reasoning skills since it is a major objective of teaching science at all levels. This will help the learners of science acquire the necessary habit of mind for experimental and productive science.

Teachers in secondary schools should teach science subject using the Hypothtico- predictive learning cycle since it is found to produce the highest learning outcome (Achievement, Attitude towards Science and scientific reasoning) irrespective of school type or administrative mode.

IMPLICATION FOR PRODUCTION OF FUTURE SCIENTISTS

The study holds huge implications for realizing Nigeria's dream of producing indigenous scientists from her schools to meet her scientific and technological needs. If this dream must become a reality, science teachers must be adequately trained to innovate in the area of new pedagogic strategies that improve learning outcome in science. Continuous implementation of the senior secondary school curriculum using the expository approach undermines the objective of helping students develop habits for investigative science. The poor outcome level of the expository group, in all outcome measures and from all school- types, points to its weakness as a method of teaching science in this century. In this age of technology, development of physical and thinking skills has become paramount. The hypothetico-predictive learning cycle affords learners opportunity to get involved in the intellectual process of learning science by participatory activities thereby making science fun. There is no doubt that though the pattern of performance in the three levels of learning outcome seemed the same in all three school types, there also seem to be some social and psychological aspects of school environment that interfered with other achievement variables in the science classroom. The influences of mixed gender classroom on choice of subjects, career choice are stereotypical. Creating classrooms which provide conducive environment for learning is essential for all genders.

SUGGESTIONS FOR FURTHER STUDIES

The study is by no means conclusive. Further research is needed to determine variables that operate in Nigeria senior secondary school that affect science learning outcomes. Psycho-social aspects of coeducational and single sex schools need to be properly understood. Further studies are also needed in determining how best to encourage the acquisition of scientific reasoning skill as an outcome of instruction.

Conflict of Interests

The authors have not declared any conflict of interests.

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