



## Influence of Gender on Students' Academic Achievement in Science and Technology Education When Taught Using Innovative Strategies

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### Abstract

The paper examined the influence of gender on students' academic achievement in science and technology education taught using innovative strategies, Kogi State. Two research questions and two hypotheses guided the study. The study adopted the quasi-experimental design. The sample size of 195 students was drawn using multistage sampling procedure. The instrument SAT was validated by three experts in STE from Kogi State University, Anyigba. The reliability index of the instrument is 0.82 determined using Kurder Richardson (K-R21). Data was collected using SAT and analysed using mean, standard deviation and Analysis of Covariance (ANCOVA). The findings revealed that male students achieve higher than female fork in STE. And also there was significant impact of treatment and gender on students' academic achievement in STE. It was recommended that teachers should adopt instructional practice that gives students equal opportunities in the classroom irrespective of gender among others.

**Keyword:** Gender, Students Academic Achievement, Science and Technology Education, Cognitive Conflict Strategy, and Conceptual Change Pedagogy.

### Introduction

Science and technology form the key player in the development of any nation. This is because nations that have control of science and technology have been able to cope with global issues such as conditions of poverty, poor sanitation, illiteracy, disease, rapid increase in population and malnutrition. Science is knowledge obtained through study or practice of the operation of general laws, especially as obtained and tested through scientific method and concerned with the physical world (Njoku, 2016). Science refers to a system of acquiring knowledge which uses observation and experimentation to describe and explain natural phenomena while technology is the application of scientific knowledge (Achor, 2013). Achor opined that Science and technology has become an enterprise on which developing nations depend in order to be self-sufficient in the training of technological personnel and to sustain a viable economy and that Nigeria in the twenty first century continues to look forward to science and technology to bring about industrialisation and physical transformation. Hence science and technology is therefore receiving an increasing attention in educational sectors all over the world, Nigeria inclusive.

Science and technology is the bedrock of human development. Many of the developed nations were able to achieve the status of development through science and technology. Therefore, there is need for

adequate and equal participation of both gender (male & female) to acquire the knowledge of science and technology through the use of efficient and quality instructional strategies.

In order to guarantee quality instruction at all levels of education, emphasis has been on the use of appropriate teaching strategies that can enhance effective classroom interaction capable of giving equitable chances for either of the students' gender to acquire qualitative and right knowledge of subject matter, and having equal opportunities for participating intelligently in making rational decisions for their own wellbeing academically (Abuh, 2021). This calls for the use of student centred teaching strategies such as cognitive conflict strategy and conceptual change strategy instead of using conventional method that have been found to be deficient in creating permanent and meaningful learning in students.

Cognitive conflict instructional strategy can be defined as a strategy that destabilises student's confidence in their existing conceptions through contradictory experiences, such as discrepant invents and then enable student's to replace their inaccurate preconceptions with scientifically accepted conception (kempert, 2019). Conceptual change strategy according to Abdul and Aklilesh (2010) is defined as teaching strategy that is used to change or remove students' existing conception (i.e belief, idea, or way of thinking) that contradicts scientific conception through the use of anomalous data in experimentation.



In this study these strategies are believed to enhanced students' understanding of scientific conceptions irrespective of gender.

Gender refers to the social and cultural construct, characteristics, behaviours and rules which society ascribes to males and females (Okeke, 2015). Okeke observed that, the Nigerian school curriculum is not gender fair since its contents reflect mainly the concern of males. Science careers portray masculine images in the curriculum and more still female suffer discrimination from teachers overtly and covertly. This action automatically put the girls in a disadvantaged position for achievement in classroom interaction especially in science, technology and mathematics related subjects.

According to Okoronka (2014) males and females show great difference in their interest and career choice. These differences may be attributed to the psychological differences and cultural influences. Even parents encourage their daughters to choose professions that are not masculine in nature. United Nation Educational Scientific and Cultural Organisation (2011) has it that local customs, values have been developing in girls, and they are so deeply ingrained that some of them find it difficult to cope in areas believed to be male dominated profession. Invisible rules within the society have provided what is masculine and what is feminine. This could also be found in science, technology and mathematics classroom interaction as male students dominate the female folk in all sorts of curricular activities.

It was observed from the achievement test results conducted by Onekatu (2015) that boys and girls in the early ages perform equally in all subjects including science and mathematics, and as they grow to higher classes, the girls begin to get more interested in arts and commercial, while the boys take more to sciences. For this reason, more boys than girls are found to offer sciences. However, the issue of gender and students' academic achievement in sciences has remained a controversial issue. While some people propose that males perform better than females in sciences others argue that the reverse is the case. Denga (2014) reported that many comparisons showed that boys and girls on the average are the same on general intelligences test. Denga said that, girls do a little better on verbal tests and on test involving arithmetical ability. Okoye (2015) posited that no evidence is clear as to whether difference exist between males and females in academic achievement in sciences. Okoye however stated that, girls tend to do

better than boys in social sciences while boys tend to outperform the girls in sciences and mathematics. Gender differences in academic performance cannot be assumed to be due to inherent biological differences between genders even if they exist but as a result of gender role stereotyping.

Gender is a strong predictor of human conduct and many differences have been documented on attitude and behaviour that affect academic achievement in males and females (Bike, 2013). Njoku and Usman (2013) argued that females perform lower than males in mathematics and sciences subjects because the subjects are considered male domain and that any female performing highly in the subjects (sciences & mathematics) is mostly treated with disdain, by her female peers and with open hostility and aggression by her male peers. Thus females are not encouraged to do and perform well in science and mathematics by the society.

Supporting the argument, Samba and Eriba (2013) found that males achieved better than females in sciences and technology related subjects taught by either gender (male or female) teacher at the senior secondary school level, while Ugwuadu (2013) finding showed that there was no significant difference between male and female students achievement in mathematics and science subjects irrespective of the gender (sex) of the teachers. Okeke (2016) in a study discovered that gender composition has a significant interaction effect with students' academic achievement. Okeke observed further that the sex of teacher whether male or female has effect on students' performance. Girls excelled especially in subjects that are taught by man, (Douglas, 2014). Douglas stressed that this is probably one explanation for girls' success at the primary and early secondary school years. Supporting this position, Oriator (2015) held the opinion that girls do better at all levels than boys in achievement even in areas such as arithmetic's where boys seem to excel, girls seem to have better grades. There is no consensus as to whether gender of the students or teachers affect achievement in science and technology related subjects or not. The present study therefore is targeted at investigating the influence of gender on students' academic achievement in science and technology education in secondary schools. Specifically, the study:

1. examined the effect of cognitive conflict instruction and conceptual change pedagogy on the academic achievement of students in science and technology education.



2. determined the influence of gender on academic achievement of students in science and technology.

In line with purpose, the following research questions were posed.

1. What is the effect of cognitive conflict instruction and conceptual change pedagogy on students' academic achievement in science and technology education?
2. What is the influence of gender on students' academic achievement in science and technology education?

Based on the objectives of the study, the following hypotheses guided the study.

HO<sub>1</sub>. There is no significant effect of cognitive conflict instruction and conceptual change pedagogy on the students' mean academic achievement in science and technology education.

HO<sub>2</sub>. There is no significant influence of gender on the students' mean academic achievement in science and technology.

## Methodology

These study adopted quasi-experimental research design, specifically, pre-test and post-test non-equivalent control group design. The design was considered appropriate for the study because intact classes were used and were randomly assigned to both treatment and control groups. Intact classes were used for the study in order not to disrupt normal classes. The population of the study comprised 7380 secondary school II students selected from all the 153 secondary schools in Kogi East education zone of Kogi State (Ministry of Education, 2019). SSII classes were used for the study because there was considerable coverage of science syllables by SS2 class when compared with SS1 class. Secondly, SS2 classes were not involved in preparing for any examination such as WAEC and NECO like their counterparts in SS3 class.

Multistage sampling procedure was used to obtain the sample for the study. The breakdown is that random sampling technique was used for selecting three local government areas, purposive sampling technique was employed in selecting six (6) secondary schools with the sample size of 195 secondary school two students in Kogi East education zone for the study. Out of these six schools, four schools were assigned to experimental groups(E1&2) while the remaining two schools were assigned to the control group using simple random sampling technique by balloting in addition, out of the sample size of 195,

112 were male students while 83 were female students. 69 male and female students were taught (physics chemistry, biology & mathematics) by both male and female teachers using cognitive conflict instructional strategy. 63 students were taught using conceptual change strategy as experimental group 2. Finally, 63 students were taught by both male and female teachers using traditional instructional strategy as control group. All the teaching was done by following the detailed lesson notes prepared for the 2 experimental groups and the control group.

The instrument used for data collection was tagged Science Achievement Test(SAT) constructed by the researchers with forty (40) multiple-choice items from standardised west Africa examination council past questions in the respective subjects, physics, chemistry, biology and mathematics. The items in the instrument had four options A-D to aid achievement of the purpose of the study. The instrument was made up of four major sections according to subject achievement test that were combined to form a single achievement test tagged Science Achievement Test (SAT). Section A is Mathematics Achievement Test (MAT) with ten 10 multiple-choice test items, section B is Physics Achievement Test-(PAT) with ten (10) multiple choice items, section C is Chemistry Achievement Test (CAT) with ten (10) multiple choice items and section D is Biology Achievement Test (BAT) with ten (10) multiple choice items. The four sections of the achievement test were put in a single instrument tagged Science Achievement Test (SAT) and the title is preceded by the demographic data of the respondents and information.

The instrument was face and content validated by three experts. Two in science education and one in measurement and evaluation from Kogi State University Anyigba, 20 copies of the instrument was trial tested in a school not part of a sample area of the study. The reliability index was determined kuder-Richardson formula (K.R21) and was found to be 0.82.The choice of kuder Richardson formula was because the instrument SAT was dichotomously scored. The reliability estimates of 0.82 show that the instrument is reliable for the study. At the beginning of the experiment 'SAT' instrument was administered to both students in the respective-schools as with the aid of the class teachers. At the end of the test, scores of the students on the pre-test were recorded and kept. The same instrument (SAT) was administrated to the students at the end of the treatment period. Later, the



scores obtained from the post-test were subjected to statistical analysis. Mean and standard deviation were used to answer the research questions while the analysis of Covariance (ANCOVA) was used to test the 2 null hypotheses at an alpha level of 0.05 level of significance.

## Results

The results of data analysis were presented based on

the two research questions and two null hypotheses that guided the study.

### Research question 1

What is the effect of cognitive conflict instruction and conceptual change pedagogy on students' academic achievement in science and technology education?

**Table1:** Mean and Standard Deviation Scores of Student's Achievement Scores X Treatment

Strategies	N	Pre-test		Post-test		Mean gain/loss
		Mean	SD	Mean	SD	
Cognitive conflict strategy	69	48.11	8.01	84.12	12.98	36.01
Conceptual change strategy	63	43.01	7.49	71.14	11.68	28.13
Lecture method	66	33.80	6.10	49.45	8.06	15.65

In table1, the result of data analysis revealed that in pre-test, cognitive conflict strategy had mean of 48.11 with a standard deviation of 8.01, conceptual change pedagogy had mean of 43.01 with standard deviation of 7.49, while lecture method had mean score of 33.08 with standard deviation of 6.10. The table also shows that in the posttest, cognitive conflict strategy had a mean score of 84.12 with standard deviation of 12.98, and mean gain of 36.01, conceptual change pedagogy had a mean score of 71.14 with a standard deviation of 11.67 and mean gain of 28.13 while the lecture method had a mean score of 49.45 with a standard deviation of 8.06 and a mean gain of 15.65.

This shows that students taught using cognitive conflict strategy and conceptual change pedagogy groups gained more in achievement scores than their counterparts in the lecture method group.

**Research Question 2:** What is the influence of gender on students' academic achievement in science & technology education?

**Table 2:** Mean Scores of Male and Female Students Taught Science & Technology Subjects.

Table 1: Mean Scores of Male and Female Students Taught Science & Technology Subjects.

Gender	N	Pre-test		Post-test		Mean gain/loss
		Mean	SD	Mean	SD	
Male	112	52.36	13.25	76.69	10.21	24.33
Female	83	48.25	13.11	67.26	12.83	19.01
Mean difference		4.11		9.43		5.32

The results of data analysis presented in Table 2 above revealed that gender seemed to have differential effect on male students. This is because male students had a mean score of 76.69 and a standard deviation score of 10.210 while the female students had a mean score of 67.26 and a standard deviation score of 12.83 with mean gain of 5.32 in favour of the male students. This implies that male students perform better than the female students in science & technology education in the classroom interaction.

### Testing of the null hypothesis 1.

HO<sub>1</sub>. There is no significant effect of cognitive conflict instruction conceptual change strategy and lecture method on the students' mean academic achievement in science and technology education.

**Table3:** ANCOVA of Mean Achievement Scores of students taught S&TE Using Cognitive Conflict Instruction Strategy, Conceptual Change Strategy and Lecture Method.



Source Variation	Sum of square	Df	Mean of Square	F	Sig of F
Covariates	16802.679	2	8401.339	301.203	.000
Pre test	12802.679	1	12802.679	328.203	.000
Main effects	9.061	2	4.430	.117	.980
Method	638.728	2	19.364	40.816	.000
Gender	60.961	1	60.961	.244	.815
interaction	120.276	1	60.138	1.456	.208
Method*gender	120.276	2	60.138	1.456	.208
Explained	12862	4	3154.154	81.386	.000
Residual	3327.216	91	37.753		
Total	16189.374	195	169.267		

Significance at  $P < 0.05$

In the ANCOVA table, the summary of result of hypothesis 1 presented in table 3 showed that the value of  $F(1, 91) = 1.456$ ,  $P = 0.208$  is greater than at 0.05 alpha level of significance. This indicated that hypothesis 2 was rejected on the ground that the significant value at 0.05 level of significance was less than the p-value. This implies that there was significant difference between the mean achievement scores of students taught science and technology using cognitive conflict instructional strategy, conceptual change strategy and lecture method. The bivariate comparizom of the methods of teaching and its effect

on mean achievement scores of students confirmed the rejected null hypothesis. This means that S&TE could be better taught using cognitive conflict instructional strategy and conceptual change strategy than lecture method.

### Testing of the null hypothesis 2

HO<sub>2</sub>: There is no significant influence of gender on the students' academic achievement in science and technology education

**Table 4:** Analysis of covariance (ANCOVA) for students' mean academic achievement in S & TE By gender.

Sources of Variation	Sum of Square	Df	Mean of Square	F	Sign of F
Covariates	12034.301	2	60167.151	102.799	.000
Pre test	6035.378	1	6035.378	103.846	.000
Main effects	999.168	2	499.632	9.685	.000
Gender*group	2129.112	1	2129.112	42.615	.000
2-way interaction	256.510	1	256.510	4.802	.033
Explained	7508.379	4	1742.578	32.568	.000
Residual	5619.827	190	53.156		
Total	13128.306	194	110.464		

Significant at  $p < 0.05$

In the ANCOVA table, the result of hypothesis 2 presented in table 4 showed that the value of f.sig (0.000) is lower than the value of f-cal (42.615) at 0.05 level of significance; this indicated that hypothesis2 is rejected. Therefore, there is a significant impact of gender on the mean achievement of students in S&T education, taught using cognitive conflict instructional strategy and conceptual change strategy.

### Discussion of findings

The findings of this study revealed that there is significant difference in the achievement scores of students taught S&T education using cognitive conflict

instructional, conceptual change strategies and lecture method. the finding is in line with that of Okoronka (2014) and Okeke (2016) that constructivist based instruction enhances students' academic achievement. The finding also agrees with Abuh (2021) that there was significant difference in SS11 students' performance when exposed to lecture method and cognitive conflict instructional approach.

Finding also showed significant influence of gender on the mean achievement of students in S&T education in Kogi East Education Zone of Kogi State. This means that males performed better in STE better



than female folk, because female look at STE as masculine discipline. Teaching strategy adopted by teachers especially the female teachers in STE do not encourage equal gender participation in class room activities. The findings of this study conflicted with the findings of Denga (2014)) who held that female students perform better than males. Denga further reported that many comparisons showed that boys and girls on the average are the same on general intelligence testing but girls do a little better on verbal test and on test involving arithmetical ability. Also this finding disagree with that of Okoye (2015) that posited that no evidence is clear as to whether difference exist between males and females in academic achievement in science. Okoye however stated that, girls tend to do better than boys in social science; while boys tend to outperform the girls in science and mathematics. Likewise, the finding conflicted that of Oriafor (2015) who held the opinion that girls do better at all levels than boys in achievement even in areas such as arithmetic where boys seem to excel, girls seem to have better grades. However, the finding of this study is in line with the findings of Nnamani and Oyibe (2016) that male students perform better than female in science and technology education. The findings of this study is also in agreement with the findings of Njokuwu and Usman (2013) held that female students perform lower than males in mathematics and science subjects because the subjects are considered male domain and that any female performing highly in the subjects (science & mathematics) is mostly treated with disdain by her female peers and with hostility and aggression by her male peers. Thus females are not encouraged to do and perform well in science and mathematics by the society.

The findings of this present study is also in line with the assertion by Bike (2013) that gender is a strong predictor of human conduct and many differences have been documented on attitude and behaviour that affect academic performance in males and females. For instance, Okoronka (2014) documented that males and females show great differences in their interest and career choice. These differences may be attributed to the psychological differences and cultural influences. Even parents encourage their daughters to choose professions that are not masculine in nature. UNESCO (2011) has it that local customs, values have been developing in girls, and they are so deeply ingrained that some of them find it difficult to cope in areas believed to be male dominated profession. Invisible rules within the

society have provided what is masculine and what is feminine. This could also be found in science, technology and mathematics classroom instruction as male students dominate the female folk in all sorts of curricular activities.

### Conclusion

The outcomes of this study revealed significant influence of gender on the mean achievement of students in S&T education. Male student' perform better than female folk in S&T education. And that there was significant effect of teaching strategies (CCIS, CCS and LM) on mean achievement of students in S&T Education in Kogi East Education Zone of Kogi State.

### Recommendations

Based on the findings of the study the following recommendations were made that:

1. Science teacher should re-assess their classroom instructional practices to ensure that their mode of classroom instruction gives the students equal opportunities to participate in the classroom activities.
2. Government and stakeholders in the education sector should ensure gender equity in the recruitment of science, technology and mathematics teachers.

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