EFFECTS OF CONTEXT-BASED AND PROBLEM-SOLVING STRATEGIES ON ACHIEVEMENT AND GENDER IN CHEMISTRY AMONG SECONDARY SCHOOL STUDENTS IN NORTH-CENTRAL, NIGERIA

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Abstract
The study focused on the effect of context-based and problem-solving strategies on achievement and gender in chemistry among secondary school students in North-Central Nigeria. The purpose of this study was to determine the effects of context-based and problem-solving strategies on achievement and gender in chemistry among secondary school student in North central Nigeria. The design used was a quasi-experimental design that is pre-test, posttest non-equivalent non-randomized groups design. The total population of Senior Secondary School Students is five hundred and thirty-six thousand, three hundred and sixty students (536,360). The target population were (88,160) senior secondary school chemistry two students. In each of the sample state, three schools were selected from different senatorial zone making a total of mine schools. The sample size for study was 412 SSII chemistry student selected from Nine Senior Secondary Schools. A purposive sampling technique was used to select the nine students used for this study. The instrument used for the study was chemistry Achievement Test, (CAT). These instruments were validated. The reliability coefficient of the CAT instrument was determined as 0.73 using person product moment correlation (PPMC). The study lasted for 12 weeks. Three weeks was used in Niger State and six weeks was used in other three states. Post-test was given immediately after the treatment in each of the state. Description statistics of mean, standard deviation and interval inferential statistics of ANCOVA were used to analyze the data. The finding showed that the context-based teaching strategy (CBTS) has a significant effect on students' achievement, more than problem solving and expository method. The context-based Teaching strategy is more efficacious than problem-solving and expository method and Gender has no significant effect on both context-based and problem-solving strategies. The study therefore recommended that chemistry teachers should adopt it as a teaching strategy in chemistry classrooms and laboratories.

Keywords: Context-based, Problem solving, Achievement, Gender

Introduction
One of the main objectives of science instruction in schools is the enhancement of conceptual understanding which is the ability to explain a concept taught in one's own words having understood it well. Thus, research in science education has shifted from teacher-centered to student-centered. (Gongden, 2015). This stem from the fact that constructivists learning is becoming popular because it enhances meaningful learning and student's active engagement. Chemistry learners, therefore, should be seen to understand and construct chemistry concepts from their environment. Nevertheless, chemistry teaching and learning has been problematic as a result of the instructional strategies employ by teachers.

Poor teaching methods have been predominantly in use for a long time in the teaching of chemistry, which is traditionally based and expository in nature, such methods as demonstration, guided inquiry, discovery method which could be result oriented (Okebukola, 2013; Sunmaila & Abiodun, 2016). These methods have been reported to have made student fail to see the interdependent relationship that exist between academic content of science subject offered in schools and real-life application (Ogar & Upula, 2013).

One of the reasons adduced for students' conceptual difficulty and subsequent poor achievement in certain chemistry concept (chemical kinetics) is its method of teaching which most of the students find uninteresting (Acar & Yaman, 2011). These raise the need for better and innovative instructional method to correct this expository method. Notable among such innovative approaches are the Context-Based Teaching Strategy (CBTS) and problem-solving strategy. Context-based method helps the teachers relate the concept being thought to the students into real world situations leading to student's motivation to learn the concepts by connecting it to their day to day experiences (Acar, & Yaman, 2011). Problem solving is a method of analyzing via enough facts of a problem to arrive at answers which might encompass logical activities and could be a measure of a person decisive reasoning capacity.

Research findings over the years have consistently shown that students' achievement in various aspects of chemistry is very poor (Acar, & Yaman, 2011; Achor & Ukwuru 2014; Augustine, 2016). This poor performance in chemistry is very disturbing and if not checked, may jeopardize the placement chances of students in tertiary institutions (Nkwocha & Ezenwa, 2013). The achievement can only be feasible if teachers are actively involved in the adoption of appropriate instructional approaches that will enhance students' achievement in chemistry, the development of good study habits by the students, and adequate use of instructional material.

Educational researchers for a long time have shown concern on the influence of gender on students' performance (Augustine, 2016). Many studies such as Ajai, and Imoko (2015), Sakiyo and Badau (2015) have been conducted in the area of gender related difference in academic achievement in secondary school chemistry. Studies have shown that male students performed better, than females. While some Studies reported female superiority in chemistry achievement (Achor & Ukwuru, 2014; Augustine, 2016; Ramon, Bello & Bauchi, 2019). These contradictory evidences in academic achievement in chemistry have resulted in the need to verify the effect of context-based and problem-solving strategies on achievement of male and female students in chemistry. In view of the foregoing, this study was initiated to find out if teaching chemistry with context-based and problem-solving strategies will improve students, academic achievement, and gender in chemistry. Acar and Yaman (2011) and Ishaku (2015) concluded from their investigations that students taught using innovative teaching method such as context-based and problems solving strategies performed better than those taught using expository method in terms of achievements. Nazir, Naqvi and Khattak (2013) indicated that Context-based strategy is successful in enhancing students' achievement.

On the contrary, Igbegwu (2012) also found out that there was no significant difference in mean achievement of male and female students in chemistry. While, Nbina (2014) showed that there was no significant difference in the mean achievement scores of male and female students taught inorganic chemistry using context-based teaching strategy "The study found out that context-based teaching strategy was significantly better. It was reported that gender was a significant effect in the overall cognitive academic achievement in favour of males Ali, Hossein and Mahin (2012). Ajai and Imoko (2015) on the contrary reported a

significant gender difference in favour of males in the study of gender difference in mathematics achievement and retention scores.

Statement of Problem

The achievements of students in chemistry in Nigerian Secondary schools have been relatively poor particularly in WAEC and NECO examination. It was reported that poor performances in chemistry was due to inadequacy of methods of teaching (Acar & Yaman, 2011). This is attributed to the fact that students failed to see the relationship that exist between the academic contents of chemistry subjects offered in schools and their applicability in real life situation (Achor & Ukwuru, 2014; Augustine, 2016). Researches have also shown that many students are not choosing chemistry related field for higher education due to difficulty encountered in understanding chemistry due to its approach (Gongden, 2015). Also, evidence in the related literatures (Ajai, & Imoko, 2015; Sakiyo, & Badau, 2015; & Augustine, 2016) shows that instructional methods influence students' academic outcome in chemistry, among them is the students' gender. This necessitated the need for exploration of context-based teaching (CBTS) and problem-solving strategies (PSS) whether it would improve students' achievement and gender in chemistry. To guide this study research questions were stated.

Research Questions

The following research questions were raised to guide the study:

(i) What is the difference in the achievement of secondary school students taught chemical kinetics with Context-Based Teaching Strategy (CBTS), problem solving strategy (PSS) and those taught with expository method?

(ii) What is the difference in the achievement of male and female students taught chemical kinetics using CBTS

(iii) What is the difference in the achievement of male and female students taught chemical kinetics using PSS

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

$HO_{1:}$ There is no significance difference in the achievement of secondary school students taught chemical kinetics with Context-Based Teaching Strategy (CBTS), Problem Solving Strategy (PSS) and those taught with expository method.

$HO_{2:}$ There is no significance difference in the achievement of male and female students taught chemical kinetics using CBTS.

$HO_{3:}$ There is no significance difference in the achievement of male and female students taught chemical kinetics using PSS.

Methodology

The experimental research design used for this study is a quasi-experimental design using pre-test, post-test non-equivalent non-randomized group design. The design was considered appropriate because intact class was used. Pre-test was administered before experimentation, while Post-test was administered after the treatment in order to determine the achievement of Chemistry students. The dependent variables for the study are students' achievement in chemistry while moderating variable is gender. The independent variables are the instructional strategies which include context-based and problem-solving strategies and Conventional Method used on control group. The population of the study consists of all Senior Secondary Schools in North Central States of Nigeria. SSS II chemistry students were the target population. There is a total of One thousand five hundred and forty-six Senior Secondary Schools (1546) located in North Central Nigeria. The total population of Senior Secondary School Students is five hundred and thirty-six thousand, three hundred and sixty

students (536,360). The target population which is Senior Secondary School Chemistry two (SSS II) students is Eighty-eight thousand one hundred and sixty (88,160). Senior Secondary School Chemistry two students for 2018/2019 academic session were used for the study.

Three states using simple random sampling technique by the application of hat-draw method were selected. In each of the sample states, government co-educational schools from each of three senatorial zones were selected making a total of nine schools. The sample size for the study was four hundred and twelve (412) SS II Chemistry students selected from nine senior secondary schools. Purposive sampling technique was used to select the nine schools for the study. Three schools were exposed to experimental group 1 within the nine schools, three were exposed to experimental group 11 and the other three were exposed to control group. A Simple random sampling technique was used to select an arm of the SS two classes as an intact class of SS II for each senatorial zone. . The instruments used for data collection in this study were Chemistry Achievement Test (CAT). The instruments were validated and certified valid for the purpose intended for the research. The reliability coefficient of the Chemistry Achievements Test (CAT instrument) was determined as 0.73 using Pearson Product Moment Correlation (PPMC).Mean Standard deviation and ANCOVA was used for data analysis. Mean, Standard deviation was used to answer the research questions, while ANCOVA was used to analyze the hypotheses at 0.05 level of significant.

Results

Research Question One: what is the difference in the achievement of secondary school students taught chemical kinetics with Context-Based Teaching Strategy (CBTS), problem solving strategy (PSS) and those taught with expository. To answer this research question, mean and standard deviation was used nd the analysis presented in Table 1.

Table 1: Pre-test and post-test results for context-based, problem-based and expository methods in Chemistry Achievement

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Context-based	133	16.30	5.64	58.00	9.20	41.70
Problem-solving	136	18.29	5.77	41.91	7.81	23.62
Expository	143	22.96	8.48	36.09	13.43	13.13

The result in table 1 indicates the mean and standard deviation of the pre-test and post-test of Context-based, problem-solving and expository methods. The pre-test mean of the three groups were 16.30, 18.29 and 22.96, while the post-test means were 58.00, 41.91, 36.09 respectively. The three groups improved on their chemistry achievement. However, students that learn with context-based strategy had the highest mean gain of 41.70, and the problem-solving learning mean was 23.62 while the control group has the least mean gain of 13.13.

Research Question Two: what is the difference in the achievement of male and female students taught chemical kinetics using CBTS?

Table 2: Pre-test and post-test results of male and female students in Context-based Strategy

	Gender		Pre-test		Post-test		Mean Gain
		N	Mean	SD	Mean	SD	
Context-based	Male	73	16.16	5.83	58.11	8.61	41.95
	Female	60	16.46	5.47	57.88	9.95	41.42

The result in Table 2 indicates the mean and standard deviation of the pre-test and post-test scores on Context-based of male and female students. The pre-test means of the male and female are 16.16, 16.46 and standard deviation of 5.83 and 5.47, while the post-test means are 58.11 and 57.88 with standard deviation of 8.61 and 9.95 respectively. The male and female improve in their chemistry achievement. However, the male had the highest mean gain of 41.91 than the female 41.42.

Research Question Three: what is the difference in the achievement of male and female students taught chemical kinetics using Problem solving strategy?

Table 3: Pre-test and post-test results of male and female students in Problem-solving Strategy

	Gender		Pre-test		Post-test		Mean Gain
		N	Mean	SD	Mean	SD	
Problem-solving	Male	77	17.94	5.57	42.54	7.78	24.60
	Female	59	18.71	6.05	41.06	7.85	22.35

The result in Table 3 indicates the mean and standard deviation of the pre-test and post-test of problem-solving strategy, male and female. The pre-test means of the male and female are 17.94, 18.71 and standard deviation of 5.57 and 6.05 respectively, while the post-test means are 42.54 and 41.06 with standard deviation of 7.78 and 7.85 respectively. The male and female improve in their chemistry achievement. However, the male had the highest mean gain of 24.60 than the female 22.35.

Pre-test Results

The pre-test data was analyzed using Analysis of Variance (ANOVA) because the groups are more than two and the findings is presented in Table 4

Table 4: Pre-test ANOVA Results of Context-Based, Problem-Solving and Expository Teaching Strategy

	Sum of Squares	df	Mean Square	Fcal	p-value
Between Groups	3254.523	2	1627.262		
Within Groups	18943.030	409	46.315	35.13	.000
Total	22197.553	411			

Table 4 shows the pre-test result of the three groups (context-based, problem-solving and expository) before the treatment. The result indicated that there is a significant difference between the three groups $F(2, 409) = 35.134$, $P(0.00) < 0.05$. Therefore, the pre-test will be used as a covariate in the analysis of the post-test data.

Hypothesis One: There is no significant difference in the achievement of secondary school students taught chemical kinetics with Context-Based Teaching Strategy (CBTS), Problem Solving Strategy (PSS) and those taught with expository method.

Table 5: ANCOVA Result for Context-Based, Problem-Solving and Expository Group Chemistry Achievement

Source	Type III Sum of Squares	df	Mean Square	Fcal	p-value	Partial Eta Squared
Corrected Model	40068.25[a]	3	13356.08	135.86	.00	.500
Intercept	57688.50	1	57688.50	586.82	.00	.590
Pre-test (covariate)	4964.97	1	4964.97	50.50	.00	.110
Group	40064.96	2	20032.48	203.77	.01	.500
Error	40108.60	408	98.30			
Total	917720.00	412				
Corrected Total	80176.85	411				

Results in Table 5 shows post-test findings of context-based, problem-solving and expository instructional strategies. The value F (3, 408) = 203.77, P= (0.01) < 0.05, indicates a significant difference between the mean of the context-based, problem-solving and expository group achievement in chemistry. The partial eta square (n^2) (.500) shows that about 50% of total variances of chemistry achievement scores (dependent variable) is due to the effect of instructional strategies.

Therefore, the hypothesis which states that there is no significant difference in the achievement of secondary school students taught chemical kinetics with Context-Based Teaching Strategy (CBTS), Problem Solving Strategy (PSS) and those taught with expository method was rejected. To determine the direction of the significant difference Sidak multiple comparison was conducted and the result is presented in Table 5

Table 5: Sidak Post-hoc Multiple Comparison of achievement of secondary school students taught chemical kinetics with Context-Based Teaching Strategy (CBTS), Problem Solving Strategy (PSS) and those taught with expository method

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Context-based	Problem-solving	17.109*	1.218	.000	14.189	20.028
	Expository	25.314*	1.287	.000	22.228	28.400
Problem-solving	Context-based	-17.109*	1.218	.000	-20.028	-14.189
	Expository	8.205*	1.234	.000	5.246	11.165
Expository	Context-based	-25.314*	1.287	.000	-28.400	-22.228
	Problem-solving	-8.205*	1.234	.000	-11.165	-5.246

Sidak post-hoc analysis on Table 5 indicated that the observed significant difference was between context-based learning group and Problem-solving learning group with the mean difference of 17.10, P-value of .000 which is significant at 0.05 level. There was a significant

difference between Context-based learning and the expository group, the mean difference is 25.31, *P*-value of .000 which also is significant at 0.05 levels. The mean difference is in favour of context-based learning group. Similarly, there was a significant difference between problem-based learning group and the expository group with the mean difference of 8.20, p=0.01, the mean difference is in favour of the problem-solving learning group. Therefore, the context-based and problem-solving group did better than the expository group, however, the group that contributed most to making it significant is found between context-based and problem-solving group.

Hypothesis Two: There is no significant difference in the achievement of male and female students taught chemical kinetics using CBTS. To test for this hypothesis Analysis of Variance (ANOVA) and the result is presented in Table 6

Table 6: ANOVA comparison of Male and Female Chemistry Score using Context-based Strategy

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.943	1	1.943	.023	.880
Within Groups	11182.057	131	85.359		
Total	11184.000	132			

Table 6 presents the post-test ANOVA results of Male and female students that learned using context-based teaching strategy. The results indicates that there is no statistically significant difference in the chemistry achievement scores of male and female students F (1,131) =.023, p (.88)> 0.05. Hence, hypothesis twowhich state that there is no significant difference in the achievement of male and female students taught chemical kinetics using CBTS was accepted.

Hypothesis Three: There is no significant difference in the achievement of male and female students taught chemical kinetics using problem solving strategy. To test for this hypothesis Analysis of Variance (ANOVA) and the result is presented in Table 7

Table 7: ANOVA comparison of Male and Female Chemistry Score using Problem-solving Strategy

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	71.274	1	71.274	1.167	.282
Within Groups	8183.667	134	61.072		
Total	8254.941	135			

Table 7 presents the post-test ANOVA results of male and female students that learned using Problem-Solving Teaching Strategy (PSS). The result indicates that there is no statistically significant difference in the chemistry achievement scores of male and female students F (1,134) = 1.16, p (.28) > 0.05. Hence, hypothesis three which state that there is no significant difference in the achievement of male and female students taught chemical kinetics using problem solving strategy was accepted.

Discussion

The finding of hypothesis one indicates that context based and problem-solving strategies are more effective in enhancing students' achievement in Chemistry than the teaching methods. In other words, students achieved better when taught with context-based and problem-solving strategies the control group. The finding also indicates a significant difference between the mean of the context-based, problem-based and expository group

achievement in chemistry. The mean difference is in favour of context-based learning group. Similarly, there was a significant difference between problem-solving learning group and the expository group with the mean difference of 8.20, p=0.01, the mean difference is in favour of the problem-based learning group. Therefore, the context-based and problem-solving group did better than the expository group, however, the group that contributed most to making it significant is found between context-based and expository group. The finding indicates that context-based and problem-solving strategies are more effective in enhancing students' achievement in chemistry than expository teaching method.

This finding is in agreement with studies of Acar & Yaman (2011), Ramzan (2011) Ceyhan, (2012), Cheem, (2013) and Ishaku (2015) These researchers concluded from their investigations that students taught using innovative teaching method as context-based, problems solving strategies performed better than those taught using expository method in terms of achievements, Sunmaila, Olufemi, & Abiodun (2016) and indicate that Context-based strategy is successful in enhancing students achievement.

This study also shows that there is no significant difference in the achievement of male and female students taught chemical kinetics using CBTS. This may generally mean that students' achievement in chemical kinetics is not related to whether male or female. This finding appears to support the view of Igbegwu (2012) who found out that there is no significant difference in mean achievement of male and female students in chemistry, Nbina (2014) carried out a study on Relative effectiveness of context-based teaching strategy on senior secondary school students achievements in inorganic chemistry. The result showed that there was no significant difference in the mean achievement scores of male and female students taught inorganic chemistry using context-based teaching strategy "The study found out that context-based teaching strategy was significantly better. However, the finding also differ from the findings of Allu (2011) who reported that gender was a significant factor in the overall cognitive academic achievement in favour of males and Ajai and Imoko (2015) who reported a significant gender difference in favour of males. The observed insignificant difference in the mean chemistry achievement scores for male and female students in this study would be attributed to their improved understanding in chemistry using context based teaching strategy

Similarly, the results also indicate that there is no statistically significant difference in the chemistry achievement scores of male and female students taught problem solving strategy. The findings is in agreement with the finding of Jegede and Fatoke (2014), Ishaku (2015), Fatoke, Ogunlade and Ibidiran (2013) who found out that there was no significant difference in the achievement of male and female students taught chemistry using problem solving strategy. However, it disagrees with the finding of Jacobson (2010),, Ramzan (2011), Augustinah and Anuan (2014) who found that gender was a significant factor in the academic achievement of male and female students in chemistry. This finding appears to support the view of Igbegwu (2012) who found out that there is no significant difference in mean achievement of male and female students in chemistry.

Conclusion

This study was shown that the context based teaching strategy (CBTS) has a significant effect on students' achievement on chemical kinetics more than problem solving and expository method. The context-based Teaching strategy is more efficacious than problem solving and expository method. The influence of gender on mean achievement score were significant using context based and problem-solving strategies.

Recommendations

Since context based is found to be an effective teaching strategy for improving students mean achievement score, mean interest score and mean retention score in chemistry.

i. Chemistry teachers should adopt it as a teaching strategy in chemistry classrooms and laboratories.
ii. Workshops and seminars should be organized for in service chemistry teachers.
iii. The teacher training institutions should include the use of context-based in their chemistry method course comment to ensure the training of the pre-service chemistry teachers.

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