

Cooperative Classroom Interaction as Predictors of Students' Academic Achievement in Chemistry

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Abstract

This study was conducted to determine the predictive power of cooperative classroom interaction on students' academic achievement in chemistry in Kogi East and West senatorial districts. Two research questions and two null hypotheses guided the study. A correlational statistical research design was used. The population of the study was 7,617 with a sample size of 384 SS II Chemistry students. Multistage sampling procedure was adopted. Two instruments were used for data collection which were Chemistry Cooperative Classroom Interaction Inventory (CCCII) and Chemistry Achievement Test (CAT). Content validity of CAT was developed using table of specification, the construct validity of CCCII was determined using factor analysis and 15 items considered factorially pure were selected while the impure were rejected. The reliability indices obtained for CCCII was 0.87 while reliability index of 0.71 was obtained for CAT. Data collected were analysed using regression analysis, Analysis of Variance (ANOVA) and t-test. The findings showed that the Predictive power of Cooperative classroom interactions on students' Academic Achievement in Chemistry is moderate and significant; the Predictive power of Cooperative classroom interactions on students' academic achievement in chemistry as moderated by gender is moderate and significant. Based on the findings, it was recommended among others that Conferences, seminars and in-service training in chemistry should be organized by school administrators and government for teachers to enable them gain adequate knowledge and experiences on cooperative classroom interaction style and use it during chemistry instruction.

Keywords: predictive power, cooperative classroom interaction, chemistry

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Introduction

Science is the systematic study of our environment which builds and organizes knowledge in the form of testable explanation and predictions about the universe. Science is the most important and major channel in which knowledge is transmitted. Through the application of science nations are built, societal aspirations and goals are achieved. The benefits of science lie on building knowledge about the universe and constructing new ideas that illuminate the world around us. These ideas are inherently tentative, but as they cycle through the process of science again and again and are tested and retested in different ways, we become increasingly confident in them. Furthermore, through this same interactive process, ideas are modified, expanded, and combined into more powerful explanations. There are three major branches of science which includes biology, chemistry and physics.

Chemistry has been one of the cornerstones of science, technology, and industry. It is apparent that chemistry plays a greater role in National Development through the industries in the world (Ibrahim et al., 2017). Chemistry is a branch of science that deals with constituents of matter like atoms molecules, ions, etc.; and its properties, structure, behaviour, and interactions among them (Anne, 2019). Rocke and Usselman (2021) defined Chemistry as the science that deals with the properties, composition, and structure of substances (defined as elements and compounds), the transformations they undergo, and the energy that is released or absorbed during these processes. Chemistry is a branch of science that deals with the study of matter, its compositions, structural appearance, properties, and principles that govern the changes that take place within matter. Every substance, whether naturally occurring or artificially produced, consists of one or more of the hundred-odd species of atoms that have been identified as elements. These atoms, in turn, are composed of more elementary particles; they are the basic building blocks of chemical substances. Chemistry, therefore, is concerned not with the subatomic domain but with the properties of atoms and the laws governing their combinations and how the knowledge of these properties can be used to achieve specific purposes.

The knowledge of Chemistry has led to the creation of environmentally friendly chemicals, cosmetics, fine and heavy chemical for industrial production of goods for the happiness of mankind. Chemistry provided mankind with a large number of life-saving drugs. Also, we have environment-friendly chemicals that help us conserve nature. One such example is the replacement of Chlorofluorocarbons (CFCs) in refrigerators. Because of the advancements in science and the discoveries of chemistry, there is an increase in Comfort, Pleasure, and Luxury life styles today. Despite the numerous importance of Chemistry to mankind and the society at large, and Governments' efforts in making several provisions that will facilitate the teaching and learning of Chemistry in Senior Secondary Schools, Chemistry is still plagued with poor academic achievement. This is observed in the chemistry students results in West African Examination Council (WAEC) as reported by the Chief Examiner's report 2020 - 2023.

WAEC Chief Examiner's Report stated that students had problems in understanding the demands of the questions, exhibited poor communication skill, wrote trivial names instead of formulae, lacked adequate knowledge of chemical concepts, could not draw correct and workable diagram for the preparation of chlorine gas in the laboratory and could not write the correct formula of a compound. Students lacked understanding of simple concepts in chemistry, had poor communication skill, were unable to give proper definition of concepts, unable to write formula instead of names, unable to write correct IUPAC names of organic

compounds among others. These attested to poor Students' academic achievement at senior secondary school Chemistry.

Students' academic achievement in Chemistry has always been a concern of the Nigerian government, researchers, teachers, school administrators and parents. Many researches have been carried out and some factors which contributed to the poor academic achievement on students were identified to include; poor teaching pedagogy and class size, school and class environment, teacher's attitude, qualification, teaching style, as well as lack of instructional and learning materials and low instructional supervision. Also reported that students with dysfunctional characteristics such as lack of confidence, low self-esteem, lack of self-control, and high anxiety are said to have low emotional intelligence, and this may affect their academic achievement (Michael & Ismail, 2016). The academic achievement of students can be enhanced using cooperative classroom interaction.

Cooperative classroom interaction is a learning strategy employed in the classroom where students work in subgroups and interact effectively. Members of each subgroup work towards mutual goals and complete class assignment or exercise together during teaching/learning processes. The teacher's job here is providing the enabling environment with varieties of learning activities as to improve students' understanding of the subject. According to Johnson et al. (2014) cooperative learning is instructional method in which teachers organize students into small groups, who then work together to help one another learn academic contents. Using this strategy, the goals of separate individual are linked together and that there is a positive correlation among the group members in order to achieve success. Cooperative classroom interaction is a process involving people working together and having an influence on each other. This is always observed in the way students behaves, work together, relate with people at home and in school (peer group and home). The relationship between the learner and the teacher forms an integral part of the teaching-learning process. Cooperative classroom interaction is a learning strategy that organizes students in small groups so that they can work together to maximize the learning of others. In particular, cooperative classroom interaction is a learning strategy in education where students are organized in pairs or in small groups to help each other in learning the assigned material (Ajaja & Eravwoke, 2012).

The tasks of cooperative classroom learning are usually intellectually demanding, creative, open, and involve higher-order thinking tasks. Cooperative learning can therefore allow weak students to learn and achieve the maximum (Ajaja & Mezieobi, 2018). Brady and Tsay (2010) opined that students who fully take part in group activities, provide useful feedback and positive behaviour which is essential for their academic carrier. According to Jacobs et al. (2016) cooperative classroom interaction involves principles and techniques for helping students work together more effectively. Cooperative classroom interaction is a student-centered pedagogy in which the teacher's role changes from being the teacher to facilitator of students' learning thereby making them acquire new knowledge themselves, also illustrated that the scope of Cooperative classroom interaction extends beyond simply grouping students and assigning them tasks. Rather, Cooperative classroom interaction requires students to cooperate among themselves and depend on each other to perform classroom tasks. According to Gillies (2016) learners can exchange ideas and knowledge to achieve shared goals in a Cooperative classroom interaction environment. This implies that social interaction fosters positive learning that results in greater achievement for all class or group members. Er et al. (2014) revealed from studies that majority of students preferred cooperative classroom interaction to individual learning because cooperative classroom interaction helped to better

understanding of their study contents and participate in classroom activities. Jacobs et al. (2016) stated that cooperative classroom interaction, improves collaboration skills, student attitudes towards learning, creates opportunities for teachers to assess student learning, and influences student's academic achievement. Bareerah (2014) found that Cooperative classroom interaction promotes students' participation and achievement in learning. The findings of Murad (2015) indicated that students had both positive and negative opinions regarding cooperative classroom interaction.

Some students preferred cooperative classroom interaction since positive collaboration among group members helped them learn from each other and finish their tasks in a short period. On the other hand, some students preferred not to share their ideas with others, and others disliked group work and considered it a time for relaxation. Students achieve more in learning when they negotiate their understanding through class discussion, interaction with peers, and exchange of thoughts and ideas (Oviawe et al., 2016). Kalu (2009) conducted a study on classroom interaction patterns and students' learning outcomes the findings of the study showed a significant positive relationship that exists between interaction pattern and students' post-instructional attitude and achievement. Ajaja and Eravwoke (2012) in their research "effects of cooperative learning strategy on junior secondary school student's achievement in integrated science" revealed that cooperative classroom interaction learning when used as an instructional strategy brings significant improvement on students' academic achievement. Can this positive observation be seen in other science subject especially Chemistry? This present study seeks to find the predictive power of cooperative classroom interaction on students' academic achievement in chemistry irrespective of their gender.

Gender bias and misconceptions has remained the main focus and of great concern in the field of science education. It is the socially and culturally constructed characteristics and roles that are ascribed to males and females in any society. It is a major factor that influences the career choice, subject interest, and academic performance of students; women are hindered from progressing through discrimination based on gender, early marriage, and childbearing, and as a result, they are deprived of sound education, job opportunities and incapacitated, and rendered passive generally in the society.

There has been a great interest by researchers into whether there is relationship between gender and Chemistry Cooperative Classroom Interaction Inventory (CCCII). Although opinions and findings vary, it seems that Cooperative Classroom Interaction differs between the sexes. These variations could be a result of social and biological influences. Some features are viewed as desirable for one gender but not the other, for example, assertiveness is a "typical" masculine trait whereas empathy is viewed as a desirable female trait. Gender has been regarded as an essentially social phenomenon (Meshkat & Nejati, 2017). According to their study, males and females are socialized differently – females are encouraged to be cooperative, expressive and tuned in to their interpersonal world, whereas males are encouraged to be competitive, independent and instrumental.

Researchers have expressed diverse views about gender and academic achievement, especially in sciences including chemistry. Some researchers opined that male students do better than female students while others like Ogunleye and Babajide (2011) disagree with this view, arguing that achievement is a factor dependent on several factors such as socio-economic background, teaching method, among others. Ezeudu and Obi (2013), also showed that male students achieved significantly better than the female students in both urban and rural schools. Daniella et al. (2014) put forward that the more masculine characteristic that

young adults had, the more they are attracted to a masculine career such as engineering or mechanic and the less attracted to a feminine career such as teachers or social worker. Arsaythamby et al. (2015) in their research disclosed that male students obtained significantly higher achievement in chemistry when measure up with the female counterparts between Malay and Chinese students. Oviawe et al. (2016) reported that gender has no significant effect on students' academic achievement. In the report of Ndirika and Ubani (2017), there is no significant difference in the mean scores of male and female students' academic achievement.

Statement of the Problem

The consistent decline in students' academic achievement in external examinations in Chemistry has been an issue of great concern in Nigeria especially in Kogi State. This is evident in the report of WAEC Chief Examiner from 2020-2023. This issue of consistent decline in the academic achievement of students in Chemistry has raised concerns and worries among educational stakeholders. Researchers have identified several factors that may be responsible for this consistent poor achievement of students in Chemistry. These factors among others include; poor teaching methods, poor study habit, lack of qualified teachers, stress, pressure tolerance for ambiguity, anxiety, interest, lack of finance to pay fees, motivation and experience factors like age, and more. Gender has also been identified to be factor that could influence students' academic achievement in chemistry.

Despite the numerous government efforts through its agencies and schools in making several provisions that could facilitate students' academic achievement in chemistry, it is still plagued with poor academic achievement. The implication of the foregoing is that students' academic achievement in Chemistry may continue to decline if further investigations are not sought. The researchers believe that lack of cooperative classroom interaction could be factors responsible for this poor achievement of students in Chemistry. Therefore, it is imperative to find out if Cooperative classroom interactions could predict students' academic achievement in chemistry while considering the moderating role of gender in Kogi East and West senatorial districts of Kogi State. Therefore, this study looks forward to ascertaining how students' academic achievement relates to their level of cooperative classroom interactions, with regards to gender.

Scope of the Study

The study "cooperative classroom interaction as predictors of student's academic achievement in chemistry" was conducted among SS II Students in the two senatorial districts of Kogi State. The study sought specifically to find the predictive power of cooperative classroom interaction on students' academic achievement based on gender. The choice of the senatorial districts is due to student's poor academic achievement as viewed in the WAEC Chief Examiners' Report 2020 to 2023 and the SS II termly results of students from the few schools in the area of study. SS II Chemistry students were selected because they have sufficiently experienced enough classroom teaching/learning of chemistry and their next class is SSCE year. The study was conducted in both public and private secondary schools to ensure co-educational uniformity.

The content scope that was covered in this study were standard separation techniques for mixtures, acid-base reactions, chemical industries, organic chemistry and periodic table of elements. This is because students showed poor understanding of simple concepts in the

above topics in chemistry, poor application of the knowledge of the periodic table, could not give proper definition of concepts when required, inability to write formula instead of names, inability to write correct IUPAC names of organic compounds among others as noted by WAEC chief examiner's report.

Research Questions

The following research questions guided the study;

1. What is the predictive power of Cooperative classroom interactions on students' academic achievement in Chemistry?
2. What is the predictive power of cooperative classroom interactions on students' academic achievement in chemistry as moderated by gender?

Hypotheses

The hypotheses were tested at 0.05 level of significance:

HO₁: Cooperative classroom interaction is not a significant predictor of students' academic achievement in chemistry.

HO₂: The predictive power of cooperative classroom interactions on students' academic achievement in chemistry as moderated by gender is not statistically significant.

Research Methods

This study employs a correlational research design. Correlation is the statistical technique for establishing the extent of relationship, association, or co-variation between two or more variables (Nworgu, 2015). This research design was considered appropriate because the researcher is interested in establishing the relationship between cooperative classroom interaction and students' academic achievement in chemistry.

The population of the study consists of all the 7,617 SS II Chemistry students in Kogi East and West senatorial districts [Source: Kogi State Ministry of Education 2021]. This population is made up of 4182 males and 3435 females SS II chemistry students. The sample for the study consists of 384 SS II chemistry students. This was determined using Taro Yamen formula.

Disproportionate stratified random sampling technique was used to draw one LGA each from the three selected educational zone. This will give a total to three LGAs. The choice of disproportionate stratified random sampling technique is to make sure that all the zone is present in the final sample. Disproportionate stratified sampling technique was used to draw four (4) schools each from the three LGAs made up of Igala, Bassa and Okun. This will give a total of (12) schools in all. Also, disproportionate sampling technique was used to stratify the students in each sampled school based on gender and 32 students comprising 16 males and 16 females was drawn. This gives a total of 384 SS II chemistry students made up of 192 males and 192 females.

Two Instruments were used for data collection in the study, which are Chemistry Cooperative Classroom Interaction Inventory (CCCII) and Chemistry Achievement Test (CAT). Chemistry Cooperative Classroom Interaction Inventory (CCCII) consist of 15 items adapted from Achurra, Lourdes and Calvete, (2015) which was originally 44 items on cooperative learning application scale. The CCCII is divided into two sections A and B which was filled

by the respondents. Section A provided personal data of the respondents such as gender, while section B measures students' cooperative classroom interactions. The instrument has 4-point rating scale of Strongly Disagreed (SD) = 1, Disagreed (D) = 2, Agreed (A) = 3, and Strongly Agreed (SA) = 4. The Chemistry Achievement Test (CAT) which consist of 30 multiple-choice items was developed by the researcher. CAT has two sections, A and B which was filled by the respondents. Section A provided their personal data; identification, gender and tribe while section B measure their achievement in chemistry.

To determine the face validity of the instruments; CCCII and CAT together with the study title, purposes of study, research questions, hypotheses, marking guide for CAT and table of specification was sent to three experts from the Department of Science Education, University of Nigeria Nsukka. Two of the validators were from Chemistry Unit and one from the Measurement & Evaluation Unit. The researcher requested the assistance of the validators for constructive criticism with respect to the; appropriateness of the instrument, suitability of the instrument for the respondents, clarity of language of the instrument, structure of the instrument and suggestions that will improving the instrument. The face validation of these instrument was done to ensure that; the items were clearly stated and unambiguous, no spelling errors, proper numberings were done, no item was double-barrelled, suitability of the items relate to the class of the students. The corrections and inputs made by the experts were used to modify and draft the final copy of CCCII and CAT.

To estimate the reliability of instruments, a trial testing was conducted on a group of students with similar characteristics to the intended sample of students; 20 SS II chemistry students in Otutu Community Sec. School Otutu Okene Kogi central senatorial district were used for trial testing since this place are outside the sampled senatorial districts for the main study. The data for the reliability estimate were collected using the various instruments (CCCII and CAT).

The estimate of internal consistency of the instrument CCCII was determined using Cronbach alpha method. The choice of Cronbach-alpha was because it is the most suitable method of estimate internal consistency reliability for instruments that are polytomous scored (that is, instrument with no right/wrong responses). The reliability indices for CCCII was 0.874.

The internal consistency reliability for CAT instrument was established using Kuder-Richardson (K-R) formula 20. This method was used because it is highly suitable for estimating internal consistency reliability for instruments that are dichotomously scored (i.e., instrument with no right/wrong responses). A reliability index of 0.71 was obtained for CAT.

The data collected from the field was analysed using regression analysis. Regression analysis was used because it is most suitable statistical technique used for predicting the relationship between two or more variables. This analysis technique is chosen because the study seeks to find the predictive power of cooperative classroom interaction on students' academic achievement in chemistry. Essentially, research questions 1 was answered using linear regression while research question 2, was answered using multiple regression. The predictive power of cooperative classroom interaction on students' academic achievement in chemistry were determined using regression coefficient (R) and coefficient of determination (R²). Correlational coefficients (R) was classified into low (0 – 0.3), moderate (0.31 – 0.80) and high (0.81 -1) (Nworgu, 2015). ANOVA was used to test hypotheses 1 while hypotheses 2 was tested with the t-value and the associated probability value obtained using process Macro, all at 0.05 level of significance.

Results

Research Question One

What is the predictive power of cooperative classroom interactions on students' academic achievement in Chemistry?

Table 1

Regression Analysis for the Predictive Power of Cooperative Classroom Interactions on Students' Academic Achievement

Model	N	R	R ²
1	384	.654 ^a	.426

a. Predictors: (Constant), C_C_Int

Table 1 above shows the regression analysis for the predictive power of cooperative classroom interaction on students' academic achievement in Chemistry. The result shows that a correlation coefficient (R) of 0.65 was obtained. This means that there is a moderate positive relationship between cooperative classroom interaction and academic achievement of students in Chemistry. The coefficient of determination (R²) is 0.43. This means that cooperative classroom interaction has a predictive power of 43% of the academic achievement of students in Chemistry.

Hypothesis One

Cooperative classroom interaction is not a significant predictor of students' academic achievement in Chemistry.

Table 2

ANOVA Result of the Predictive Power of Cooperative Classroom Interaction on Academic Achievement

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12812.179	1	12812.179	284.961	.000 ^b
	Residual	17175.153	382	44.961		
	Total	29987.332	383			

The result in Table 2 shows the ANOVA result of the significant of the predictive power of cooperative classroom interaction on academic achievement of students in Chemistry. The result shows that an F-ratio (1, 382) = 284.961, p = 0.000 was obtained. Since p = 0.000 is less than 0.05 level of significance, the null hypothesis is rejected. Inference drawn is that, cooperative classroom interaction is a significant predictor of students' academic achievement in Chemistry.

Research Question Two

What is the predictive power of cooperative classroom interactions on students' academic achievement in Chemistry as moderated by gender?

Table 3

Multiple Regression Analysis of the Predictive Power of Cooperative Classroom Interaction on Students' Academic Achievement As Moderated by Gender

Model	N	Interaction	R	R ²	SE	Df	t	p
1	384	Gender x Cooperative classroom interaction	.6700	.4489	.0761	382	3.6141	0.0003

Table 3 reveals the predictive power of cooperative classroom interactions on students' academic achievement as moderated by gender. The result shows that a correlation coefficient (R) of 0.67 was obtained. This is an indication that there is a moderate positive relationship between cooperative classroom interactions and academic achievement as moderated by gender. The coefficient of determination (R²) of 0.45 shows that 45% of the predictive power of cooperative classroom interactions on the academic achievement of students is moderated by gender.

Hypothesis Two

The predictive power of cooperative classroom interactions on students' academic achievement in Chemistry as moderated by gender is not significant.

Table 3 above shows the significant of the predictive power of cooperative classroom interactions on the academic achievement of students in Chemistry as moderated by gender. The result revealed a t-value of 3.6141 at 382 degrees of freedom with an exact probability value of 0.0003. This probability value of 0.0003 is less than 0.05 level of significance, hence, the null hypothesis is rejected. Conclusion drawn is, the predictive power of cooperative classroom interactions on students' academic achievement in Chemistry as moderated by gender is significant.

Discussion of the Findings of the Study

The discussion of the findings is presented under the following sub-headings:

1. The predictive power of Cooperative classroom interactions on students' academic achievement in Chemistry
2. The predictive power of cooperative classroom interactions on students' academic achievement in chemistry as moderated by gender

The Predictive Power of Cooperative Classroom Interactions on Students' Academic Achievement in Chemistry

The findings of the study revealed that the predictive power of cooperative classroom interaction on students' academic achievement in Chemistry is moderate. Further analysis revealed that the predictive power of cooperative classroom interaction on students' academic achievement in Chemistry is significant. This result implies that cooperative classroom interaction is highly accountable for students' academic achievement in chemistry. The significance of the predictive power of cooperative classroom interaction on students'

academic achievement in Chemistry could be due to the fact that cooperative classroom interaction opens chemistry students up for intellectual involvement, creativity, and higher-order thinking tasks. It also increases cooperation and more well-developed social skills, motivation, retention of knowledge, positive interdependence, interaction and collaborative skills which are all needed for improving academic success.

The findings above are in line with the findings of Ajaja and Eravwoke, (2012), Ajaja and Mezieobi, (2018) who found that cooperative classroom interaction is a significant predictor of students' academic achievement in Chemistry. Cooperative classroom interaction helped students to better understanding of tasks, contents and active in classroom activities which leads to a better academic achievement. The findings of this present study disagree with the findings of Murad (2015) which indicated that students have negative opinions regarding cooperative classroom interaction. This disagreement may be due to location of the study and participants' characteristics.

The Predictive Power of Cooperative Classroom Interactions on Students' Academic Achievement in Chemistry As Moderated by Gender

The result from data analysis shows that Cooperative classroom interaction as moderated by gender on students' academic achievement in Chemistry is positively moderate. Further analyses reveal that the predictive power of cooperative classroom interaction on students' academic achievement in Chemistry is significant.

This result directly means that the level of cooperative classroom interaction between male and female students in respect to their academic achievement in Chemistry is different. This indicates that the relationship between cooperative classroom interaction and achievement in chemistry for males is different from that of female students. The difference could be that the levels of their involvement in teamwork, study habits, solving problems together, facilitating the completion of their tasks, guiding and assisting themselves in order to achieve common goal in chemistry classes differs. That students are allowed to study and solve problems together does not mean that their preferences or choices could be the same with respect to males and females. The differences with respect to males and females could be due to their levels of participation or involvement in group work or teamwork.

Conclusion

The study set out to investigate the predictive powers of cooperative classroom interaction on students' academic achievement in chemistry in Kogi East and West senatorial districts. Based on the findings of the study, the following conclusions were made.

The study in accordance with its findings concluded that cooperative classroom interaction has a significant predictive power on students' achievement in Chemistry. This is because cooperative classroom interaction helps chemistry students in class participation, creativity, and higher-order thinking tasks which leads to a better academic achievement. Cooperative classroom interactions are highly accountable for students' academic achievement. High level of their cooperative classroom interaction or learning styles leads to students' high academic achievement in chemistry. This study in accordance with its findings also concludes that the predictive power of cooperative classroom interaction on students' academic achievement in chemistry as moderated by gender is significant. Also, level of cooperative classroom interaction between male and female students in respect to their academic achievement in

Chemistry as moderated by gender is different. It may be as a result of differences in their levels of self-awareness, self-regulation, social skills, empathy and motivation.

Recommendations

Based on the findings of the study, the following recommendation were made;

1. Government and school administrators should be organizing conferences, seminars and in-service training from time to time to enable teachers gain adequate knowledge and experiences on emotions intelligence in order to apply them appropriately.
2. Chemistry Teachers should encourage gender equality and should encourage the use of techniques that build confidence in both males and females alike. Teachers should be gender sensitive to encourage both male and female students alike in developing chemistry skills in respective of their ethnicity.
3. Government should train and employ Chemistry Teachers who understand impact of emotions intelligence in order to achieve societal goal and aspiration.

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