

Effects of Collaborative Learning on Chemistry Students' Academic Achievement and Anxiety Level in Balancing Chemical Equations in Secondary School in Katsina Metropolis, Nigeria

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Abstract: The study investigated effects of Collaborative learning on Chemistry students' academic achievement and Anxiety level in Balancing Chemical Equations in Secondary Schools in Katsina metropolis, Nigeria. The study sampled 80 SSII students, randomly selected from two senior secondary schools in katsina metropolis. The two schools were randomly placed as experimental and control groups each with 40 students. A quasi-experimental pretest-posttest research design was used for the study. The study subjects in the experimental group was taught/ allowed to learn using Collaborative learning concept of Balancing Chemical Equation, while the control group also was taught the same concept using traditional method for the period of six weeks. A chemistry Achievement test and Students Anxiety scale Questionnaire were used as the instruments for data collection. Performance of the two groups were compared using post-test mean scores, and t-test unrelated sample, at a significant level ($P = 0.05$). The findings from the study shows those students taught using Collaborative learning tent to achieve significantly higher and their anxiety was found to be low when compared with those taught using lecture method. Based on the findings, the recommendations were made among which; Chemistry teachers should always use Collaborative learning in teaching chemistry concepts, as this method enhance students achievement and reduce students anxiety.

Keywords: *Collaborative learning, Academic Achievement, Anxiety, Balancing Chemical Equations*

1. Introduction

Chemistry is one of the important science subjects taught at the Senior Secondary School (SSS) level. It is one of the core science subjects that students are required to pass at credit level in order to qualify for admission into tertiary institutions to pursue science-based programmes. In spite of this central and important position of chemistry among others science and related disciplines, studies revealed that, academic achievement of students in chemistry at Senior Secondary School Certificate Examination (SSSCE) has consistently been very poor and unimpressive (Njoku, 2005). Many factors have been suggested as contributing to this poor performance of students in chemistry in particular and science in general. Some of these factors include: inadequate laboratory equipment in chemistry (Eniayeju, 2010); poor teaching methods (Ayogu, 2001); mathematical nature of chemistry among others. Also the West African Examination Council (WAEC) Chief Examiners Report 2009, 2010, 2011 and 2012, reported students' general poor performance in chemistry, as seen in Table 1.

Table 1: Performance of Students in Chemistry at SSCE Level (WAEC) in Katsina State, from 2009 to 2013

YEAR	No OF STUDENTS PRESENT	No OF STUDENTS PASS	No OF STUDENTS FAIL	% PASS	%FAIL
2009	1800	355	1445	23	80
2010	1905	340	1565	18	82
2011	2033	404	1629	20	80
2012	2210	401	1809	18	82
2013	2560	528	2032	21	79

Source: Katsina State Ministry of Education (2013)

From Table 1 it could be seen that chemistry students have problems/difficulties in the learning of chemistry which has resulted in poor performance at Senior Secondary School level. The concept of balancing chemical equations has been recognized as one of the basic chemical concepts in chemistry, as

suggested by Ababio, (2004). Anthony (2009) reported that the understanding of balancing chemical equation is a prerequisite to the comprehension of some learning tasks in chemistry such as chemical equilibrium, electrochemistry and organic chemistry. Balancing chemical equations also is one of the difficult concepts chemistry students encounter in both practical and theory. This is supported by WAEC chief examiners' reports of 2009, 2010, and 2011, which ascertained that, what made most chemistry students perform poorly in chemistry, was the inability of the students to write correctly, reactants, products as well as to balance the reaction equation correctly. Therefore, there is a need to find a way of solving this problem. A number of activity-oriented instructional strategies have been advocated for by curriculum designers and science educators (Eniayeju, 2001) in Dahiru (2013) to help improve on the failure rate among secondary school science students. Examples of these strategies include guided discovery approach, demonstration method, discussion method and problem-solving for teaching senior secondary school chemistry as stipulated in National Policy on Education (FME, 2004). Research findings had however, revealed that to date, a large proportion of science teachers, chemistry inclusive, still resort to the use of traditional/lecture method rather than the activity-oriented or student centred strategies advocated for, such as demonstration method, problem-solving and others (Olorukooba, 2001).

For the concepts in chemistry to be taught effectively to chemistry students in the secondary schools, collaborative learning has been considered relevant and fruitful (Lyman & Harvey, 2002). Collaborative learning is a teaching strategy involving student's participation in small group learning activities that promote positive interaction. Tinzmann (2013) observe that, collaborative classrooms have four general characteristics. The first two capture changing relationships between teachers and students. The third characterises teachers' new approaches to instruction. The fourth addresses the composition of a collaborative classroom. Collaborative learning is generally defined as a teaching arrangement in which small, heterogeneous groups of students work together to achieve a common goal. Students encourage and support each other, assume responsibility for their own and each other's learning, employ group related social skills, and evaluate the group's progress. The basic elements are positive interdependence, equal opportunities, and individual accountability. In collaborative learning students assume new roles in the classroom. Their major roles are collaborator and active participator. It is useful to think how these new roles influence the processes and activities students conduct before, during and after learning. For example, before learning, students set goals and plan learning tasks; during learning, they work together to accomplish tasks and monitor their progress; and after learning, they assess their performance and plan for future learning. As mediator, the teacher helps students fulfil their new roles. Collaborative learning has been proven to be effective for all types of students (Colorado, 2007), including academically gifted, mainstream students and Science learners because it promotes learning, peer interaction, which helps the development of language and the learning of concepts and content. It fosters respect and friendships among diverse group of students. In fact, the more diversity in a team, the higher the benefits for each student. Peers learn to depend on each other in a positive way for a variety of learning tasks. It is based on these that the researcher decided to use collaborative learning in balancing chemical equation in chemistry, and find whether it will enhance students academic achievement or otherwise. Also to find whether it will reduce student's anxiety level or not.

Studies such as Tobias, (1999) and Elliot, (2000) in Dahiru (2013) have shown that test anxiety affects performance of science students. Anxiety is defined as an unpleasant sensation that is usually experienced as feelings of apprehension and general irritability accompanied by restlessness, fatigue, and various somatic symptoms such as headaches and stomach-aches (Chiss and Hassibi, 1998 in Dahiru 2013). Anxiety may affect the academic performance of students according to (Elliot, 2000) this is called test anxiety. In other words, test anxiety is a reaction to examination stress, that is, the stress caused by testing conditions, such as examination. In this study therefore, the effect of collaborative learning on student anxiety level, will be investigated. Every society seeks economic development and innovations; this is more achievable through effective teaching and learning of scientific concepts, Otuka (2007). This is possible through activity-based teaching method, where student are allowed to learn through hands-on and mind-on activity. A society without any appreciable innovations lacks improvement in its productive capacities. Based on this the education sector, precisely the school seeks to bring Gender refers to the amount of masculinity and femininity found in an individual (Bichi, 2002). Science educators such as Yoloye, (1999), Fakorede, (2000) and Okeke, (2002) have carried out a number of studies on gender difference and science learning, and they have revealed the under representation of girls in science, mathematics and technical subjects at the secondary school level. The under representation and under achievement are most pronounced in the hard sciences i.e. the physical science (Biology, Chemistry and Physics) than natural science Lawal, (2009). It is based on this that, this study attempted to investigate if

academic achievement in balancing chemical equations is gender related or not when collaborative learning method is applied.

Statement of the Problem: Science educators, parents and other stakeholders in science education had been worried about the poor performance of students in SSCE and WASCE chemistry for quite some time now. In spite of the important position of chemistry among other science subject and related disciplines, literature have revealed that, students performance in chemistry at Senior Secondary School Certificate Examination (SSSCE) have been poor consistently, (Njoku 2005 and WAEC Chief Examiners' report 2007-2012). A study carried out by Anthony (2009) revealed that SSS students have difficulties in learning certain chemical concepts such as solubility, electrolysis, redox reaction, chemical equilibrium and balancing chemical equations. To achieve mastering of balancing chemical equation and other concepts in chemistry, several instructional strategies are device over the years. The earliest and perhaps the least affective teaching method is the expository method, commonly referred to as the traditional method, the lecture method or the chalk and talk method. Over the years science educators have been using the lecture method of teaching balancing chemical equations with little or no activities, which makes the concept difficult for students to grasp (Anthony 2009). Also studies by Tobias, (1999) have shown that test anxiety affect the performance of students in examination. Therefore Chemistry concepts cannot be taught in abstract, students need to conduct themselves in a group and exchange ideas in form of collaborative method on any given concept for them to understand better. The importance of student's centred method (like collaborative method) in science education is well known. It leads to functional knowledge/ meaningful knowledge. It is based on these that this research is set out in order to find whether the use of collaborative learning method in teaching balancing chemical equations will enhance students' academic achievement and reduce anxiety or not.

Objective of the study: The following are objectives of the study.

- To find out the effect of collaborative learning on chemistry student's academic achievement in teaching balancing chemical equations at Senior Secondary School level.
- To investigate the effect of collaborative learning on academic achievement in relation to gender among Senior Secondary School chemistry students.
- To determine the effect of collaborative learning on students anxiety level in balancing chemical equations at Senior Secondary School level.
- To investigate the effect of collaborative learning on students' anxiety level in relation to gender among SSS chemistry students.

Research Questions: The study sought answer to the following questions.

- Is there any difference in the academic achievement of Senior Secondary School (SSS) chemistry students when exposed to collaborative learning and those exposed to lecture method in balancing chemical equations?
- Is there any difference in the academic achievement of male and female Senior Secondary School (SSS) chemistry students when exposed to collaborative learning in balancing chemical equations?
- What is the difference in anxiety level of Senior Secondary School (SSS) chemistry students exposed to collaborative learning and those exposed to lecture Method in balancing chemical equations?
- Is there any difference in the anxiety level of male and female SSS chemistry students when exposed to collaborative learning in balancing chemical equations?

Hypotheses: The following hypotheses were formulated for the study

- There is no significant difference in the academic achievement of SSS chemistry students when exposed to collaborative learning and those exposed to lecture method in balancing chemical equations?
- There is no significant difference in the academic achievement of male and female SSS chemistry students when exposed to collaborative learning in balancing chemical equations?
- There is no significant difference in the anxiety level of SSS chemistry students exposed to collaborative learning and those exposed to lecture method in balancing chemical equations?
- There is no significant difference in the anxiety level of male and female SSS chemistry students when exposed to collaborative learning in balancing chemical equations.

2. Methodology

The research employed a quasi-experimental-control group design, involving pre and post test. The study involves control and experimental groups consisting of both male and female study subjects. A pre test was administered to the groups, before the treatment, to determine the group comparability. The experimental group was taught the concept of balancing chemical equations using collaborative learning, and the control group was taught the same concept using traditional/lecture method for six weeks. After the treatment a Chemistry Achievement Test (CAT) was administered and Student Anxiety Scale Questionnaire (SASQ) i.e post test. The population of the study involve all senior secondary schools within katsina metropolis. Out of those schools, two schools were randomly selected, the first school selected serve as school A and the other school B. Within the school A, 40 study subjects were also selected randomly and form experimental group, similarly in school B, 40 study subjects were also selected randomly and form control group (The study subjects in both group A and B are made up of male and female students). The instruments used for data collection was chemistry achievement test (CAT) and Students Anxiety Scale Questionnaire (SASQ). The two tests were validated by experts (i.e. two chief lecturers) in the department of chemistry education and Psychology F.C.E. Katsina. T-test unrelated sample was used to analyse the results from the two tests.

3. Results

The results obtained after the test was subjected to t-test analysis, as shown in Table 1.

Table 2: t-test Analysis of Difference in Achievement of the Experimental vs Control groups

Groups	N	X	SD	SE	DF	tval	Pval	Remark
Experimental	40	60.67	10.97	3.90	78	3.5	0.02	Significant
Control	40	49.45	6.78	1.89				

P-value =0.05 (Significant level)

Table 2: The results in table 2 shows that a p-value of 0.02 which is less than p-value of 0.05 significant level. This shows that, there is significant difference between the experimental and control group and the difference is in favour of the experimental group. This means that those students taught using collaborative learning tend to achieve significantly higher than those taught using lecture method.

Table 3: t-test Analysis of Academic Achievement between Male and Female Students in Experimental group

Gender	N	X	SD	SE	DF	tval	Pval	Remark
Male	25	43.89	11.12	9.90	38	6.4	0.03	Significant
Female	15	30.10	7.99	10.50				

P-value =0.05 (Significant level)

Table 3: The results in table 3 shows that a p-value of 0.03 which is less than p-value of 0.05 significant level. This shows that, there is significant difference between the male and female students in the experimental group and the difference is in favour of the male students. This means that male students tend to achieve significantly higher than female students when both were taught using collaborative learning.

Table 4: t-test Comparative Analysis of Students' Anxiety level between Experimental vs Control groups in Balancing Chemical Equations

Groups	N	X	SD	SE	DF	tval	Pval	Remark
Experimental	40	59.97	10.12	4.90	78	3.1	0.02	Significant
Control	40	41.95	5.98	2.89				

P-value =0.05 (Significant level)

Table 4: The results in table 4 shows that a p-value of 0.02 which is less than p-value of 0.05 significant level. This shows that, there is significant difference between the experimental and control group and the difference is in favour of the experimental group. This means that those students taught using collaborative learning tend have less anxiety level than those taught using lecture method.

Table 5: The results in table 5 shows that a p-value of 0.06 which is greater than p-value of 0.05 significant level. This shows that, there is no significant difference between the male and female students in the experimental group and the difference is in favour of the female students. This means that the anxiety level of both male female students tend to be low when both were taught using collaborative learning in balancing chemical equations.

Table 5: t-test Analysis of students' anxiety level between Male and Female Students in Experimental group

Gender	N	X	SD	SE	DF	tval	Pval	Remark
Male	25	49.59	9.12	10.90	38	28.9	0.06	Not Significant
Female	15	50.10	11.99	8.91				

P-value =0.05 (Significant level)

Discussion of the findings: From the results obtained Table 1, it shows that those students taught using collaborative learning tend to achieve significantly higher and have less anxiety level than those taught using lecture method this is in line with the findings of Usman, (2000), Ayogu 2001, Okebukola 2005 and Duniya (2009). While on the other hand the finding in Table 2 shows that male students tend to achieve significantly higher than the female students when both were taught using collaborative learning. This was supported by the findings of Adewumi (2005), Stanley (2008) and Ali (2013). The findings in Table 3 revealed that students taught using collaborative learning tend to have less anxiety level than those taught using lecture method. This is in line with the findings of Aktamis (2009). However, the findings also revealed that, there is no significant difference between the anxiety level of both male and female students when taught the concept of balancing chemical equations using collaborative learning, as seen in table 5. The findings of this study contend with the findings of Agommudhe and Nzewi (2003) and Babajide (2010) in Akpan (2012) who in their studies noted no significant influence of gender in students' anxiety level in science.

4. Conclusion

The research findings concluded that: Significant difference was found when chemistry students were exposed to collaborative learning as compared with performance of chemistry students taught with lecture method of teaching, the difference was in favour of those students exposed to collaborative learning. Similarly, the influence of gender on the academic achievement of chemistry student exposed to collaborative learning, revealed significant differences between male and female in favour of male chemistry students. Also, the research revealed no significant difference in anxiety level between male and female chemistry students taught using collaborative learning. The anxiety level was found to be low.

Recommendations: Based on the findings the following recommendations were made:

- Teachers should ensure that they teach chemistry students with collaborative learning because this method enhanced their academic achievement, hence low anxiety level.
- Both Teachers and Students must use materials/ equipment during teaching and learning process, this will help students understand science concepts, in the event where the materials are not available, teachers/students must improvise.
- Teachers should ensure that female students participate actively during the teaching and learning process using collaborative learning.
- In school where large classes exist, teacher should endeavour to sub-divide the students into smaller groups and teacher each group using collaborative learning at different time. This will help students in full participation during the lesson.

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