



EFFECTIVENESS OF COLLABORATIVE AND DEMONSTRATION METHODS OF TEACHING IN ADVANCING STUDENTS' ACHIEVEMENT AND RETENTION IN CHEMISTRY

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Abstract

This paper examined the effectiveness of collaborative and demonstration methods of teaching senior secondary school students' academic achievement and retention in chemistry. A quasi-experiment (non-randomized pretest-posttest control group) design was adopted for the study. The study comprised 114 chemistry students drawn from two different private senior secondary schools in Port Harcourt Local Government Area in Rivers State. A purposive sampling technique was used to select the two schools into experimental and control groups. Students were tested in their real-class situation, whereby the experimental group was taught using the collaborative method and the control group was taught using the demonstration method. Both groups were subjected to a pretest and after the teaching, to a posttest. The test questions were drawn from the class scheme of work. The instrument chemistry achievement test (CAT) was validated and the Cronbach Alpha method was used to determine the reliability coefficient as 0.7. Data analysis was done using means and standard deviations for the research questions while analysis of variance (ANOVA) was used for testing the research hypotheses at 0.05 level of significance. The findings of the study revealed that the collaboration method of teaching enhanced both academic achievement and retention in chemistry students more than the demonstration method of teaching. Furthermore, female chemistry students' academic achievement and retention enhanced better than their male counterparts. Based on the findings, several recommendations were made which include that curriculum developers should see the need to integrate a variety of innovative teaching strategies in the teaching-learning process as recommended by global standard practices.

Keywords: Collaboration Learning Strategy, Demonstration Strategy, Chemistry, Research, Effectiveness

Introduction

Science learning and research are geared towards the progress, growth, and development of man and his society. Many individuals and groups have made several remarkable efforts to bring this to fruition, especially science organizations such as the Science Association of Nigeria (STAN) whose discussions and annual conferences are bothered on this singular subject. The Nigerian government has in line with included in the school curriculum right from the primary level of education Basic science which at the senior secondary school level is specified as Biology, Chemistry Physic and others and at the tertiary level includes Biochemistry, Botany, Engineering, Geology, medicine, space research, nuclear energy and many more while technology applies all the efforts by science into many more products for the maximum benefit of man. Understanding science has brought about the production of quality and quantity of food, comfortable houses, clothes, furniture, transportation systems, medicines and health, just to mention but a few. Science evolved all aspects of human life and endeavour, part of the reason why those who learn chemistry would say " what on earth is not chemistry". Science also helps us to improve our understanding of the universe and natural phenomena. According to Agommuoh and Ifeanacho (2013), Science creates knowledge, economic development and wealth for any nation. Chemistry promotes a bright future by creating employment opportunities in various industries worth billions and trillions amount of money to boost the standard of living for the individual and improve the socio-economic status of any nation. We study chemistry to sustain our living in the areas of creativity, beauty, food, shelter, energy, health, clean water, air, soil and the environment at large. Chemistry is a science subject that studies the composition, structure, properties and other vital characteristics of matter and the reactions they undergo. Matters undergo reactions either by physical or chemical means to yield products which are utilized by man in several ways for his comfort. Studies in chemistry have brought a lot of innovations and renovations to life. The immense contributions of chemistry to the life of all living organisms and in all other aspects of living have been commented on separately by many including Aniodoh and

Eze (2014), and Gomollón-Bel (2019). Some of these immense contributions of chemistry to life are expressed in drug synthesis, the manufacturing of fine drugs and medicine-related materials, the manufacturing of textiles, cosmetics, paints etc. in various industries, production of food and other agricultural-related useful materials amounting to a very large sum of products utilized directly and indirectly by man especially. Though the contributions of chemistry to life are innumerable and overwhelming, most students find the concepts difficult to understand and this reason is attributed to several opinions, some say the difficulty is due to the abstractness of the concepts (Raviolo & Garritz, 2009; Prabha, 2020) and still others associate the difficulty to pedagogy especially the method of teaching (Nalevska & Kazmanovska, 2020).

Several studies have shown that when appropriate teaching strategies are adopted for teaching, particularly science, beyond gain in knowledge, retention is achieved and more so, learners acquire skills. Teaching methods are means adopted by the teacher to help the learner understand concepts, acquire skills and discover his potential such that the learner comes out better than he was before the teaching-learning process. Dorgu, (2015) defined teaching methods as different ways that teachers use in communicating subject matter to pupils that are rooted within the instructional objectives to bring about learning. Ogbuanya et al. (2017), explained that teaching methods as steps, means and procedures engaged by teachers to impact the skills and knowledge of students. Ayonmike (2014) described teaching methods as the process engaged by teachers to equip the learner with appropriate and functional skills in an environment to enable the learner to function effectively in meeting the needs of society. When an appropriate teaching method is adopted, the students stand to gain a lot Dorgu (2015) opined that teaching methods facilitate students' learning and satisfy them. More so, Thomas (2016) affirmed that a good teaching method for skill acquisition must possess qualities capable of bringing out the students' innovative abilities. Teaching methods are numerous and classification is based on conventional/Traditional and modern/innovative, other types include teacher-centred; student-centred; constructivist approach; differentiated instruction; technology-based learning; project-based learning; group learning; individual-learning(self-directed learning); inquiry-based learning etc. Teaching can be categorized into four broad types: teacher-centred, learner-centred, method-centred and content-centred (<https://vietnamteachingjobs.com>). The implication therefore is that not just any teaching method would do the job effectively and efficiently but that teaching methods that are students engaging, oriented towards innovation and creativity and that evoke curiosity in the mind of the learner are required. Modern teaching methods is the teaching method which focuses more on teaching the student to improve their intellectual behaviour by using various new and innovative ideas rather than making them recite the syllabus to clear the examination with the same old style" (Mehta,2023). Also highlighted are some characteristics of modern teaching methods, as follows:-

1. Learner significantly dominates the classroom activities,
2. It is activity-oriented hence, engages the learner with the learning materials and
3. It encourages peer collaboration.

Furthermore, modern teaching methods have numerous advantages including, making the learner acquire cognitive learning skills, application-based skills, exploring things, bringing the prefrontal cortex into life, learning relatively to the increasing needs, and developing unique patterns of learning (Mehta, 2023). There are several teaching methods, for instance collaborative, discussion, demonstration etc. among which collaborative teaching methods alongside others is accepted as a modern and innovative method of teaching and very suitable for teaching science subject in which chemistry is inclusive.

The 21st century requires modern and innovative methods of teaching science that involve students engaging or participating in useful activities. This is necessary to build the society to be a better place, and that means, creative and innovative minds should be taught in a way that would enable learners to seek information by discovery through participation. Modern teaching methods such as the collaborative methods of teaching are innovative, activity-centred, learner-oriented, exploring and discovery-targeted. Collaboration or cooperative learning is an educational approach to teaching and learning that brings a sizeable group of learners working together in an attempt to carry out a given task, solve problems or create a new idea or things. This approach to learning is in support of constructivism theory in that the learner here is made to be responsible for his learning by constructing learning based on his ideas, experience with learning materials and skills. According to Reil (2022), learning in the 21st century requires educators to extend subject matter and help students fine-tune skills for life, literacy and learning. Hence, the collaborative approach to learning requires the learner's engagement in research and discovery of things within and outside the learner's classroom environment and this means new skills, ideas and creativity are achieved for the benefit of the learner and his entire society. A collaborative approach to learning, therefore, allows the learner to be

actively involved in the learning activities beyond the limits set by the teacher within the confines of the classroom and this is a shift from teacher-centeredness to learner-centeredness. Laal and Kermanshahi (2018), opined that collaborative learning represents a significant shift from the typical teacher-centeredness or lecture-centeredness which has been the usual practice in our classrooms whereby the teacher does all the talking and the learners only listen and take notes, instead, the teacher now plays the role of expert designer of intellectual experiences for students as coaches or midwives of a more emergent learning process. Laal and Kermanshahi (2018), pointed out five basic elements in a collaborative learning environment, namely: positive independence; considerable interaction; individual accountability; social skills and group processing. Some collaborative learning strategies: are think/write – pair share; peer review; jigsaw technique; and group problem-solving (Clifford, 2020). Collaborative learning can create knowledge which can always be improved upon because this approach to learning touches all aspects of life. Hence, in collaborative learning, the learners' learning effectiveness, problem-solving ability, innovative capacity, and life-long learning in a global view are ensured (Nakagawa et al., 2017).

The collaborative learning approach improves culture and sense of belonging, encourages learners to declare their own needs, and enables students to solve problems such teams are said to attain higher-level thinking skills and preserve information for longer than students working on an individual basis reason that in collaborative learning, groups tend to learn through discussion, clarification of ideas and evaluation of others' ideas. The collaborative approach to learning is characterized by the teacher as a team player, creates structure to support collaboration, designing of learning activities, building of ample opportunity for student discussion, and flexible group norms, establish clear group goal, keep the group mid-sized etc. the students: individual responsibility, accountability and contribution in decision making, development of trust in one another, retention in knowledge etc. (Al-Kaabi, 2016; Reil, 2022).

Knowledge gained during learning is expected to be retained or kept and recalled or reproduced when necessary. By remembering what has been learnt, knowledge can be applied and be useful to benefit the learner and his society. Hence, retention entails the ability of a student to recall or remember what has been taught after a given period especially concerning measuring students' progress (Eze et al., 2016).

The demonstration method of teaching is a means by which the object of learning is displayed for a certain task to be carried out whereby learning follows sequential instruction to elucidate salient points referred to in an idea or expression. Demonstration is about doing and illustrating information (fact) usually for clarification purposes via audio, visual or audio-visual means either by direct contact or through the sense organs – eye, nose, skin, tongue, and ear. According to Khan (2020), the demonstration method of teaching is a process of teaching which is explained by presentation, experimentation and procedural manner and demonstration procedures, actions and events related to the subject are applied in the method of teaching therefore, it is a visual teaching method and gives an understanding of the material of learning both theoretically and practically. Furthermore, the demonstration method of teaching can be classified according to the number of persons involved as individual and group. The demonstration method being can be carried out by various individuals such as the teacher, students, and guest in the following manner - teacher-demonstration; teacher-student demonstration; student demonstration and guest demonstration, can also be classified accordingly as teacher-student demonstration, student-student demonstration and quest-student demonstration. The demonstration method is a traditional method of teaching in which the approach needs some essential skills and so can only be effective by the teacher who has developed special skills such, that students may not be able to perform demonstration without the required skills. This, therefore, can become a disadvantage to the practice. Demonstratively should be done with the utmost confidence on the part of the teacher because anything less than this will cause students to lose interest in the learning. Demonstration being a method of teaching within a method though in some instances can be used as a method on its own, does not stand alone in most cases so should be carried out alongside other methods of teaching.

Statement of the Problem

Chemistry must be learned and understood, especially at the foundational level which is the Senior Secondary School level, before advancement in the same or related science discipline. Many students have forfeited admission to learn Chemistry in high Schools because of their inability to perform adequately in the subject at the secondary school level which success is a pre-requisite for this admission. Success in the examination and turn admission may be achieved if the methods of teaching and learning of the subject are carried out in a manner that knowledge will be gained and sustained. Though several modern and innovative methods of teaching have been recommended and are

being practised, inconsistency is observed, the reason being that not all teachers and schools have readily adopted these methods of teaching and so, most of the students are still lagging whereas all teachers need to avail themselves with this practice. It is therefore pertinent to carry out this study on the effectiveness of collaborative and demonstration methods of teaching in Senior Secondary Schools in the Borikiri axis of Port Harcourt in Rivers State of Nigeria.

Research Questions

To guide the study, the following questions were asked:

- (1) What is the difference between the mean academic achievement scores of students taught chemistry using the collaborative method and those taught using the demonstration method?
- (2) What is the difference between the mean retention scores of students taught chemistry using the collaborative method and those taught using the demonstration method?
- (3) What is the difference between the mean academic achievement scores of students taught chemistry using a collaborative method based on gender?

Research Hypotheses

The following null hypotheses were tested at a 0.05 level of significance

- (1) There is no significant difference between the mean achievement scores of students taught chemistry using the collaborative method and those taught using the demonstration method.
- (2) There is no significant difference between the mean retention scores of students taught chemistry using the collaborative method and those taught using the demonstration method.
- (3) There is no significant difference between the mean scores of students taught chemistry using a collaborative method based on gender.

Methodology

This research adopted a quasi-experimental design, specifically, a pretest-posttest non-randomized control group where intact classes were used for both experimental and control groups. The study comprised 1911 SS II Chemistry students in Private Schools in the Borikiri axis of Port Harcourt local government area in Rivers State, Nigeria. 114 chemistry students (52 students for the experimental and 62 students for the control groups) were used for the study employing an intact class sampling technique. Firstly, a pretest was conducted on both groups after which the experimental group was subjected to a collaborative method while demonstration was done in the control group. Thereafter, a post-test and after two two-week intervals a second post-test (for retention scores) was carried out on both groups. The experimental group has 30 females and 22 males. The chemistry achievement test (CAT) consisting of 24 multiple-choice questions, was drawn from the scheme of work for the term for the particular level. The same was validated by experts in both chemistry and science education at Ignatius Ajuru University of Education, Port Harcourt Rivers State. The test-retest method was used to ascertain the reliability; which was calculated using the Cronbach Alpha method and was put at 0.7 coefficient index. Data analysis was done using means and standard deviations to answer the research questions and a 2-sample T-test was employed to test the hypotheses at 0.05 level of significance.

Results

Research Question 1: What is the difference between the mean academic achievement scores of students taught chemistry using the collaborative method and those taught using the demonstration method?

Table 1: Mean and standard deviation of students taught chemistry using the collaborative method and those taught using the demonstration method.

Method of teaching	No. of students (n)	Pretest X	SD	Posttest X	SD	Mean Difference
Collaborative method	52	7.78	4.47	11.53	6.14	3.75
Demonstration method	62	7.59	3.64	9.67	4.67	2.08

Table 1 shows that students taught using the collaborative method have a mean difference of 3.75 while those taught using the demonstration method have a mean difference of 2.08

Research Question 2: What is the difference between the mean retention scores of students taught chemistry using the collaborative method and those taught using the demonstration method?

Table 2: Mean and standard deviation of students taught chemistry using the collaborative method and those taught using the demonstration method over delayed posttest retention scores.

Method of teaching	No. of students (n)	Pretest		Posttest		Delayed Posttest		Mean Difference
		Mean	SD	Mean	SD	Mean	SD	
Collaborative method	52	7.78	4.47	11.53	6.14	9.61	5.18	1.92
Demonstration method	62	7.59	3.64	9.67	4.67	6.45	4.57	3.22

The result from Table 2 shows the mean and standard deviation of students taught chemistry using the collaborative method and those taught using the demonstration method over delayed posttest retention scores. The mean difference among the students who were taught using the collaborative method was 1.92 whereas that of those taught using the demonstration method was 3.22.

Research Question 3: What is the difference between the mean academic achievement scores of students taught chemistry using collaborative methods based on gender?

Table 3: Mean and standard deviation of students taught chemistry using the collaborative method

Gender	No. of students (n)	Pretest Mean	SD	Posttest Mean	SD	Mean Difference
Female	30	9.37	4.90	10.71	4.09	1.34
Male	22	7.54	4.09	6.80	3.62	0.74

The results from Table 3 shows the mean and standard deviation of students taught chemistry using the collaborative method. It shows that the female students taught using the collaborative method had a mean difference of 1.34 whereas that of the male students was 0.74.

Hypotheses 1: There is no significant difference between the mean achievement scores of students taught chemistry using the collaborative method and those taught using the demonstration method.

Table 4: T-test analysis of the difference between the mean academic achievement of students taught chemistry using the collaborative method and those taught using the demonstration method.

Teaching method	N	Mean	SD	DF	t-value	p-value	Alpha level	Result	Decision
Collaborative	52	3.75	1.4	112	.225	.799	0.05	Not significant	Accepted
Demonstration	62	2.08	1.12						

From Table 4 above, the calculated value of t was 0.225 while the p-value was 0.779. Since the p-value (0.225) is higher than the alpha value of 0.05 level of significance, the null hypothesis was accepted. Therefore, there is no significant difference between the mean achievement scores of students taught using the collaborative method and those taught using the demonstration teaching method.

Hypothesis 2: There is no significant difference between the mean retention scores of students taught chemistry using the collaborative method and those taught using the demonstration method.

Table 5: T-test analysis of the difference between the mean retention scores of students taught chemistry using the collaborative method and those taught using the demonstration method.

Teaching method	N	Mean	SD	DF	t-value	p-value	Alpha level	Result	Decision
Collaborative	52	1.92	0.96	112	.333	.740	0.05	Not significant	Accepted
Demonstration	62	3.22	0.1						

Table 5 above shows the calculated value of t as 0.333 while the p-value is 0.740. Since the p-value (0.333) is higher than the alpha value of 0.05 level of significance, the null hypothesis which states that there is no significant difference between the mean retention scores of students taught chemistry using the collaborative method and those taught using the demonstration method is accepted.

Hypothesis 3: There is no significant difference between the mean scores of students taught chemistry using a collaborative method based on gender.

Table 6: T-test analysis of the difference between the mean achievement scores of male and female students taught chemistry using the collaborative method.

Gender	N	Mean	SD	DF	t-value	p-value	Alpha level	Result	Decision
Female	30	1.34	0.97	50	.391	.769	0.05	Not significant	Accepted
Male	22	0.74	0.47						

Table 6 above shows that the mean achievement scores for female students taught chemistry using the collaborative method was while that of the male was 0.74, the t-value was 0.391 and the p-value was 0.769. Since the p-value (0.769) is relatively higher than the alpha value of 0.05 level of significance, the null hypothesis was accepted. The implication, therefore, is that there is no significant effect on the mean achievement scores of male and female students taught chemistry using the collaborative teaching method.

Discussion

The higher mean achievement score of students in the collaborative method is an indication that the collaborative method of teaching improved students' learning in chemistry than the demonstration method. Similarly, Edmond and Ayodele (2014) in their study revealed that collaborative learning was better at enhancing students' achievement in chemistry than the demonstration method. Meanwhile, no significant difference in the achievement of students between the collaborative method and demonstration method of teaching is in contrast with the findings of Paulinus and Nwachi (2017) who found that the cooperative learning method of teaching significantly enhanced students learning more than the demonstration method of teaching.

In retention, the mean achievement score of the demonstration method is slightly better than those of the collaborative method though there was no significant difference between both methods. Nevertheless, Sola and Ojo (2017) affirmed that the collaborative teaching method brings more significant differences in students' retention when compared with those exposed to the demonstration teaching method in the separation of mixtures as a model of the experimental aspect of chemistry. Students in collaborative teaching groups provide an avenue for learners' participation and increase their retention level to give results. The findings equally revealed a slight mean difference in the mean scores between male and female students which showed no significant difference between both, this may be associated with the fact that in collaborative learning, ideas are generated by learners who also clarify, discuss and evaluate the same.

Conclusion

This study examined the efficacy of collaborative and demonstration methods of teaching in enhancing students' academic achievement and retention of chemistry concepts. The use of modern and innovative strategies, (for example collaborative teaching strategy) particularly in the teaching of science subjects such as chemistry as shown in this study is associated with students' obvious and meaningful improved performance and retention in the subject

concepts. Finally, teamwork as suggested in the collaborative method of teaching, in the use of solving real-world problems has shown to be more favourable to female folks in the perception of information and retention of the same in long-term memory.

Recommendations

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

1. The a need for curriculum developers to integrate a variety of innovative teaching strategies in teaching science subjects, particularly in the senior secondary school curriculum.
2. Collaborative teaching methods should be used in addition to other modern innovative methods of teaching to enhance effective teaching and learning, particularly in science subjects.
3. Educational bodies should sensitize chemistry teachers through seminars, conferences and other possible means on the use of modern innovative methods such as collaborative methods in the teaching-learning process.

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