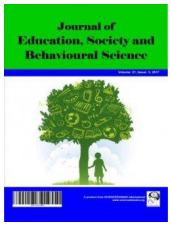

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Improving Students' Achievement in Chemistry through Cooperative Learning and Individualized Instruction

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Authors' contributions

This work was carried out in collaboration between all authors. Author IAG designed the study, conducted the experiment. Author AMO read the manuscript, guided the conduct of the study and made necessary technical corrections in the entire study. Author NAC did the data analysis, author PPO did the data collection and collation while author EF did the literature.

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ABSTRACT

The study examined the effects of Cooperative learning and Individualized instruction on students' achievement in Chemistry in Awka south LGA of Anambra State. Three hypotheses were tested. The quasi-experimental design was used, specifically the pre-test posttest non-equivalent control group design. A sample of 118 Senior Secondary School two (SSS 2) Chemistry students from Awka South LGA was used in the study. The instrument for data collection was Chemistry Achievement Test (CAT) validated by one lecturer in science education Nnamdi Azikiwe University, Awka, one lecturer in measurement and evaluation Federal College of Education Technical, Umunze, and one experienced chemistry teacher in British Spring College, Awka. The reliability of the instrument was established using Kudder-Richardson formula 20 which yielded coefficient of internal consistency of 0.92. The data obtained were analyzed using mean, and multivariate

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analysis of covariance (MANCOVA). The results revealed that there was a significant difference between the mean achievement of students in chemistry taught using cooperative learning, individualized instruction and conventional method in favour of cooperative learning as the most effective, followed by individualized instruction. There were no significant differences in the mean achievement scores of male and female students and the disordinal interaction effect of teaching methods and gender on achievement was not significant. The study recommended that chemistry teachers should adopt cooperative learning strategies and individualized instruction to involve students in the learning process actively and make them take more responsibility for their own learning.

Keywords: Individualized instruction; cooperative learning; constructivism; noble gases; gender-sensitive.

1. INTRODUCTION

1.1 Background to the Study

The various methods of instruction are normally anchored on some theories of learning. Notable among these theories in recent times is the theory of constructivism. The constructivists hold the view that learning should primarily involve the learner and facilitate the learners' ability to conceptualize learning contents. Thus, meaningful learning takes place when the learners are socially involved. Teaching methods that enable students' subject matter conceptualization and student to student as well as teacher to student interactions could enhance achievement as students can learn from each other's concepts that they could not learn directly from the teachers. Such learning approaches are better suited for teaching and learning science concepts including chemistry. Chemistry is the branch of science that deals with the properties, syntheses and uses of matter [1]. Ability to achieve these objectives of teaching chemistry requires proper conceptualization of chemistry concepts. This would require teaching and learning approaches that could make students practice science knowledge gained, achieve good grades in chemistry and apply the learned concepts in their daily lives as scientists to be. Two methods that come to mind at this point are cooperative and individualized methods since they are student-centred.

Cooperative learning is the instructional use of small groups so that students' work together to maximize their own and each other's learning [2]. Techniques involved in cooperative learning include: Think-pair-share, Jigsaw, Jigsaw II, Reserve jigsaw, Inside-outside circle and Reciprocal teaching [3]. This study made use of think-pair-share method. In Think-pair-share (TPS), the educator encourages the students to refine a critical response to a provocative prompt through individual contemplation, small group conferences and group discussion of their conclusion [4]. Research-based evidence has shown that cooperative learning improves students' learning outcome and educators have recognized cooperative learning as a beneficial teaching-learning technique for different subjects [5]. Closely related to cooperative learning is individualized instruction which is another innovative instructional method that also has the potential for improving academic achievement.

Individualized instruction consists of any steps taken in planning and conducting programs of studies and lessons that suit them to the individual students' learning needs, learning readiness and learner characteristics or learning style. It is an instructional procedure designed to take into account the individual's aptitude and ability of students [6]. According to [7], individualizing instruction means the tailoring of instruction to the particular needs, aptitudes and abilities of the learner, in which case the learner works at his or her own pace. The basic factor that differentiates this method of instruction from other methods lies in who determines the objectives, the methodology and materials to be used in achieving the objectives. In this study, the self-directed individualized Instruction (SDII) was used. In SDII, the objectives are stated for all students to reach, all materials needed to attain the objectives are provided and students are allowed to choose how they can attain the objectives.

The effects of individualized instruction on achievement are varied. In the view of [8], the positive effect of individualized instruction could be attributed to the learning modes. The learning mode in individualized instruction allows for self-pacing. Thus, the individuals learn at their own

pace, taking their time to understand difficult materials, ask questions, and make inquiry. This kind of learning raises the motivation in the learner since the understanding of one concept sustains in them the motivation that they can learn the next related concepts since the learning is systematically planned. This therefore could affect achievements positively.

The individualized instruction method can be approached and achieved through different methods such as Programmed Instruction (PI), Computer Assisted Instruction (CAI), Independent Study (IS), Audio-Tutorial Training Models (ATTM), Learner-Controlled Instruction (LCI), Personalized System of Instruction (PSI), Protocol Packages (PP), and Learning Activity Package (LAP) among others [9]. Neboh found a significant difference in students' biology achievement when Individualized Instruction was used. In this study, the Self-Directed Individualized Instruction (SDII) was used. The ideas underlying the concept of individualized instruction are that learners differ in their learning characteristics and that these differences need to form the basis for planning instruction for every individual learner. [10] in their study found that individualized instruction increased students' achievement and was significantly better than the conventional teaching approach such as lecture method.

Researchers who have conducted studies directed towards instructional methods that could improve achievement in chemistry have unianimously supported the adoption of innovative teaching methods by chemistry teachers. [11] investigated the effect of a virtual chemistry laboratory (VCL) on students' achievement. The findings from the study revealed that VLC is as effective as the real laboratory in teaching laboratory practical. [12] conducted a study on effect of science process skills teaching strategy on boys' and girls' achievement in chemistry in Nyando District, Kenya. The findings of the study revealed that science process skills teaching approach improved academic achievement. [13] also investigated the effects of science process skills mastery learning approach on students' acquisition of selected chemistry practical skills in school. The results of the study indicated that students in the experimental groups outperformed the control groups in the acquisition of selected Chemistry practical skills. [14] studied the effects of usage of sequential teaching method on the academic achievement and retention level of students in area of biological sciences or biochemistry. The findings of the study established that the best sequence of teaching methods for teaching biochechemistry was slide demonstration – student experiment – lecture method.

All these conducted in chemistry and chemistry related fields, the methods adopted by the researchers proved more effective than the conventional method in improving students' achievement in chemistry. However, none of these studies delved into student to student interaction and how it could improve achievement in chemistry. The studies also did not examine how students could learn individually with or without assistance from the teacher and its effect on academic achievement in chemistry. The current study therefore, sought to investigate the beneficial effects of cooperative learning and individualized instructions as compared to the conventional methods of teaching.

The conventional method involves any set of methods used by the teacher in lesson delivery which are often teacher-centered. Typical example are the lecture method and chalk talk method. Lecture method is a teacher-centred approach to teaching and learning in which the teacher is seen as an authority, dispensing knowledge to students who contribute little or nothing to the instruction. Lecture method has been criticized by [15] who posited that only hardworking students can benefit from it. The classrooms in Nigeria are predominantly dominated by such conventional method of instruction which does not encourage students-students interaction. The common use of conventional method is obviously due to the fact that it is suitable for teaching a large number of students and saves a lot of time. It also requires lesser skill on the part of the teachers who use the approach.

Another critical factor that propels teachers' adoption of conventional method of instruction is the time duration of the lesson and the overload of subject matter content. In Nigerian secondary schools, the time duration for a lesson is 45 minutes or 40 minutes for a single period of lesson. Double lesson periods last for 80 minutes. For each subject including chemistry, teachers have a total of three periods of lesson

making up a total of 120 minutes or 135 minutes at maximum. This time duration is not flexible as it is clearly mapped out in the school timetable to ensure orderliness. The time duration however, is not often enough for chemistry teachers who would need to conduct practical lessons and teacher the theories while ensuring that the content areas as contained in the scheme of work is covered for the term. In an attempt to cover the scheme of work, chemistry teachers would barely give room for students' active participation during instruction.

The overloaded content of the chemistry curriculum as perceived by secondary school teachers has been a subject of interest. Content areas such as "Models of Atoms" and "Chemistry of Space" are perceived by some secondary school teachers to constitute curriculum overload. For these teachers, the basic knowledge about the concepts should be taught. Students should be exposed to more content areas at higher institution when they chose the aspect of chemistry they want to study. To meet up with the perceived overloaded curriculum, conventional methods of teaching becomes the easiest way. Teachers may just write lesson notes on the board and have students copy the note while she reads from the board and explain. Some teachers' use of conventional method may comprise giving out the lesson notes to the students to copy on their own and the teacher comes to teacher thereafter. Whatever the approach, the method is often teacher-centred. Conventional method as a teacher-centred approach makes for students' passivity and therefore leads often times to poor academic achievement.

The students' poor academic achievement in Chemistry has been noted in the West African Examination Council (WAEC) Chief Examiners' Reports from 2010 to 2017. From the analysis of the students' performance in WAEC shows that the raw students' mean scores from 2010 to 2017 never exceeded 40%. The problem of poor academic achievement in science seems to be the central focus of attention in most science education research nowadays. Most of the researchers aim at finding the solution to students' continuous poor achievement reported in science subjects including Chemistry. None of the studies in Awka Education Zone of Anambra state of Nigeria, however, to the best of the researchers' knowledge, has focused on the students' interaction among themselves and learning alone and how this can affect their chemistry achievement. The researchers therefore, saw the need to explore this area to determine whether approaches that challenge the students and enhance interaction could significantly affect achievement in chemistry positively since cooperative and individualized methods have the potential to improve achievement for male and female students.

The reports on gender as a factor in students' achievement in sciences are mixed. While some findings indicated no significant effect of gender in chemistry achievement [16,17]. Some researchers reported significant influence of gender on academic achievement. This study therefore sought to examine the influence of gender on the achievement of students.

1.2 Statement of the Problem

The secondary school Chemistry is taught with a variety of methods. However, most of the methods of instruction in the researchers' observation in secondary schools within Awka South local government areas often neglect the interaction among students and between the students and the teachers. In [18] view, a great deal of emphasis is placed on teachers' responsibilities to ensure that students have appropriate interactions with materials (such as textbooks and computers) and that students have appropriate interactions with the teacher, but relatively little time is spent structuring opportunities for students to have meaningful and appropriate interactions with each other and personalized thoughts. Interpersonal interaction is necessary for a proper functioning of the school system. It promotes cognitive and social development and also impacts the quality of peer relationships as well as their achievement, the absence of which could lead to under-achievement in Chemistry. Also, Chemistry observably is filled with a lot of concepts that demand a lot from both the teacher and students in order to be properly learnt. The lack of resort to innovative teacher methods that could facilitate greater interaction has led to continuous poor achievement in chemistry. The raw mean scores of the students' achievement in chemistry in Nigeria both the practical and essay examinations have never exceeded average. This is shown according the WAEC Chief Examiner's Reports in Table 1.

Table 1. Students' raw mean score and Standard Deviation (SD) in chemistry

Year	Paper 1 (practical)		Paper 2 (Essay)	
	Raw mean score	SD	Raw mean score	SD
2007	25.00	10.30	-	-
2008	20.00	9.27	-	-
2009	-		35.00	15.65
2010	29.00	5.54	36	16.52
2011	24.00	9.27	32.00	18.39
2012	24.00	9.59	30.00	13.89
2013	-		44.00	15.72
2014	25.00	9.06	35.00	16.94
2015	27.00	8.83	436.00	15.62
2016	-	-	43.00	15.36

Source: https://www.waeconline.org.ng/e-learning/Chemistry/chemmain.html

The students' poor achievement in Chemistry as noted in WAEC Chief Examiners' Reports has often been attributed to method of instruction among others. There is need therefore, to adopt a method of teaching that can facilitate interaction among students, with teachers and instructional resources. The use of cooperative and individualized instructions were therefore, investigated.

1.3 Hypotheses

1. There is no significant difference in the mean achievement scores of students in chemistry taught using cooperative instruction, individualized instruction and those taught using conventional method.
2. There is no significant difference between the mean achievement scores of male and female students.
3. There is no significant interaction effect of teaching methods and gender on students' achievement in chemistry.

2. METHODOLOGY

2.1 Population and Sample

The design adopted for this study is quasi-experimental. Specifically, the pretest posttest non-equivalent control group design was used. The design is presented in Fig. 1.

Group	Pre-test	Treatment	Post-test
E_1	0_1	X_1	0_2
E_2	0_1	X_2	0_2
C	0_1	$\sim X$	0_2

Fig. 1. Design of the experiment

Where,

E_1 = Experimental Group I
E_2 = Experimental Group II
C = Control Group
0_1 = Pre-test
0_2 = Post-test
X_1 = Treatment I – Cooperative method
X_2 = Treatment II – Individualized method
$\sim X$ = No treatment – Conventional teaching method

The area of study is Awka South local government Area in Awka Education Zone of Anambra State, Nigeria. The population of the study consists of all the 2,065 (840 males and 1225 females) senior secondary school two (SS II) Chemistry students in Awka South Local government Area (Source: Post Primary Schools Services Commission, Awka, 2017). The sample for the study comprised 118 senior secondary two (SSII) Chemistry students from three schools. The sample was drawn using multi stage sampling techniques. Purposive sampling was used to select only coeducational schools in the local government area and schools that are far apart. This is to avoid interaction among the groups. The three schools have two arms of science class each. Simple random sampling was then used to assign treatment samples. The names of the schools were written on pieces of paper, folded and kept on a table. A little boy who was not part of the students was asked to pick one paper at a time. The first school picked by the boy was noted as experimental group 1, the second as experimental group 2 and the remaining as the control group.

2.2 Instrument for Data Collection

Chemistry Achievement Test (CAT) developed by the researcher was used as instrument for the

study. The CAT items in the achievement test were constructed based on the topics used in the lesson plans. The questions were constructed using the table of specification to establish content validity. The test is made up of 20 objective test items to be answered in 50 minutes. The instrument was validated by one lecturer in Science Education Department in Nnamdi Azikiwe University, Awka, one lecturer in Measurement and Evaluation in Federal College of Education Technical, Umunze and one experienced Chemistry teacher in British Spring College, Awka. They were required to validate the instructional techniques, the lesson contents in line with the question and hypotheses. The validation required that they retain, delete or modify items in the CAT based on the plausibility of the distracters, the clarity of sentence and question, and items in line with the objectives of the lesson. The reliability of the CAT was established using the Kuder-Richardson 20 formula method. The rationale behind this method is that it is appropriate for objective test items that are dichotomously scored with heterogeneous difficulty level. The instrument was administered on 40 chemistry students in Onitsha High School, Onitsha and the obtained scores were tested for reliability using the formula as stated below:

$$r = \frac{Kd^2 - \bar{X}(K - \bar{X})}{d^2(K-1)}$$

Where,

K = number of items
$\bar{X}$= mean score
d = standard deviation

The reliability index obtained was 0.92.

2.3 Experimental Procedure, Data Collection and Analysis

The three groups in the study were taught the lesson contents as contained in the lesson plans. The experimental group one (E1) was taught using the cooperative method, group two (E2) using the individualized method and group three (3) using the conventional method.

Experimental group 1: The experimental group one was divided into groups of four as used in the Think-pair-share approach. Each group was assigned a group head who coordinated the activities of the group, collected written assignments and submitted group reports to the teacher. The group heads were also responsible for leading group presentation or appointing a member to present. Each group were given the concepts to be taught and required to prepare notes and presentation for which each group member answered questions relating to the concepts given their group to discuss on. Group assessment was also given to each group to be submitted and scored on group basis to facilitate group cooperation. However, during the posttest each individual was judged according to his/her performance. In the treatment procedure, group one after they have done their assignment by interacting with their group members and resolving on what to present, the teacher during the lesson called each group to make their presentation and have other group members ask questions on the presentation that were made. After the discussion, the teacher continued the lesson by clarifying confusing issues relating to the topics treated.

Experimental group 2: For the experimental group 2, the objectives of each lesson was made clear to the students in their intact classes and organization of learning contents as well as learning materials such as textbooks, notes were made available to the students. This is because the students were going to study on their own as required by the Self-Directed Individualized Instruction (SDII) used in the study. Thereafter, the students were given assignments and guidance on how to attend to the assignments. The assignment was done on individual basis but with the assistance of the teacher should any of the steps in the assignment prove difficult. Students were given evaluative tasks and feedback given to them on each task carried out with the necessary corrections. The teacher was also available at any point in time to attend to students with any difficulty relating to the given tasks.

Control Group: The control group was exposed to the same content using conventional method. Chalk and talk technique was applied with little questions attended to by the teacher. Students in the control group were not grouped together. General assignment was given to the whole class and everyone was expected to submit at the same time.

The CAT instrument was administered as pretest before the treatments without feedback on their performance. After the treatment, the CAT was again administered as a posttest with a reshuffling of the items. The scores were then collated and organized for analysis. The experiment lasted for 8 weeks with the lesson for

each week lasting for double periods. The null hypotheses were tested for significance using Multivariate analysis of covariance (MANCOVA) to remove the initial group differences among the students. The decision rule was: reject null hypothesis when P-value is less than (<) 0.05, otherwise do not reject the null hypothesis.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Hypothesis 1

There is no significant difference in the mean achievement scores of students in chemistry taught using cooperative instruction, individualized instruction and those taught using conventional method.

The analysis of hypothesis 1, 2 and 3 are presented in Table 1.

Table 1 shows that at 0.05 level of significance, there was a significant main effect of the treatment on students' achievement in chemistry, Pvalue < 0.05. Null hypotheses 1 was rejected. Thus, there is no significant difference in the mean achievement scores of students in chemistry taught using cooperative instruction, individualized instruction and those taught using conventional method.To determine the order of significant difference, Scheffe Post-Hoc test was ran.

The scheffe's post-hoc analysis shows that there is a significant difference in the mean achievement scores of students taught chemistry using cooperative learning and those taught using conventional method in favour of cooperative learning. There is also a significant difference in the mean achievement scores of students taught chemistry using cooperative learning and those taught using individualized instruction in favour of cooperative learning. There is also a significant difference in the

Table 2. Summary of MANCOVA analysis for testing hypotheses 1, 2 and 3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	6971.185[a]	6	1161.864	6.833	.000	
Intercept	84534.222	1	84534.222	497.134	.000	
Pretest	293.235	1	293.235	1.724	.192	
Method	6489.434	2	3244.717	19.082	.000	S
Gender	12.211	1	12.211	.072	.789	NS
Method * Gender	163.386	2	81.693	.480	.620	NS
Error	18874.789	111	170.043			
Total	635975.000	118				
Corrected Total	25845.975	117				

Table 3. Scheffe's Post-Hoc test to compare the experimental and control groups

(I) Method	(J) Method	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
Cooperative Learning	Conventional method	18.247*	2.961	.000	12.380	24.114
	Individualized method	8.201*	2.980	.007	2.297	14.105
Conventional method	Cooperative Learning	-18.247*	2.961	.000	-24.114	-12.380
	Individualized method	-10.046*	2.950	.001	-15.892	-4.200
Individualized method	Cooperative Learning	-8.201*	2.980	.007	-14.105	-2.297
	Conventional method	10.046*	2.950	.001	4.200	15.892

mean achievement scores of students taught chemistry using individualized instruction and those taught using conventional method in favour of individualized instruction. Table 2 shows that out of the three methods, cooperative learning proved most effective.

3.1.2 Hypothesis 2

There is no significant difference between the mean achievement scores of male and female students.

From Table 1, there was no significant difference between the mean achievement scores of male and female students, Pvalue > 0.05. Null hypothesis two was not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students.

3.1.3 Hypothesis

There is no significant interaction effect of teaching methods and gender on students' achievement in chemistry.

From Table 1, there was no significant interaction of teaching methods and gender on students' achievement in chemistry, P > 0.05. Null hypothesis three was rejected. Therefore, there is no significant interaction of teaching methods and gender on students' achievement in chemistry. This implies that the students' achievement scores relative to the teaching methods was not influenced by gender as shown in Fig. 2.

Fig. 2 shows that the plot of the interaction effect between gender and teaching method is not significant and disordinal. This implies that although, the effects of the teaching methods on achievement relative to gender was not significant, the methods were gender sensitive as shown in Table 3.

From Table 3, it can be seen that male students had higher posttest mean score than the females in the cooperative learning group and individualized instruction group but in the conventional method, female students had high posttest mean score than the males.

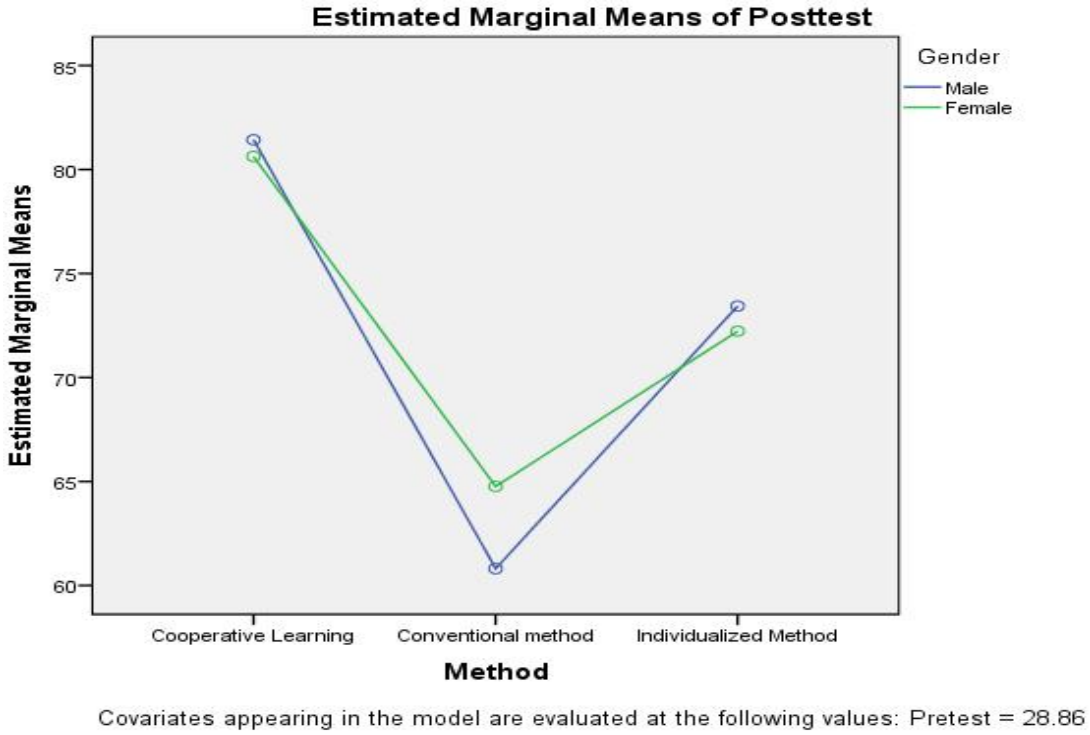

Fig. 2. Plot of the interaction between gender and teaching methods on achievement

Table 4. Method * gender interactions on achievement in chemistry

Methods	Gender	Mean	Std. Deviation	N
Cooperative Learning	Male	81.39	11.607	18
	Female	80.50	14.039	20
	Total	80.92	12.780	38
Conventional method	Male	61.09	15.736	23
	Female	65.00	11.882	18
	Total	62.80	14.144	41
Individualized Method	Male	73.10	10.779	21
	Female	72.22	13.198	18
	Total	72.69	11.801	39
Total	Male	71.05	15.341	62
	Female	72.86	14.392	56
	Total	71.91	14.863	118

4. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

4.1.1 Discussion

The findings of the study revealed that Cooperative learning significantly improved the students' Chemistry achievement. The students in the Cooperative learning group had mean gain significantly higher than their counterparts in the conventional group. Cooperative learning was also more effective than Individualized instruction as shown by the mean gain. This improvement in the achievement of Chemistry students through the use of Cooperative learning can be explained from the fact that Cooperative learning increased personal, social and intellectual development, academic attainment and positive interaction among students; cooperative instructions engage students in group and thereby increase learning, education, knowledge and skills [19]. The improved achievement can be further explained in the views of [20] who reported that cooperative instruction enabled students of different levels and ability to use available learning activities and those known to improve their understanding in chemistry owing to the interaction among students in small teams. Thus, in their interaction, students who understand a particular concept in the subject of study help the others to understand the same. In this exchange of knowledge, all students within a group with time may come to master the subject matter content under study, achieve the required learning objectives and improve their achievements.

In cooperative learning, students of low ability are afforded the opportunity of learning outside the classroom. Getting to seek peer help and learning in unofficial ways provides the motivation to learn. Also, since the students may meet other students of similar ability in their group, they build their self-confidence. Interest in learning may also be aroused and sustained. Students in cooperative learning may also devise different approaches to tackle a single problem. These variations in the approach to the solution of a problem result in more interaction with the learning materials and metacognition. Students may begin to evaluate their own learning and where they are not doing well, they seek the immediate help of their peers which often time is readily available. This is why cooperative learning may have improved the achievement of students in chemistry significantly.

The findings of this study is supported by [21] who reported that students taught using Cooperative learning outperformed those taught using conventional methods of teaching. The findings of the study is further supported by the findings of [22] who examined the effects of Cooperative learning on the academic achievement, social interaction, behaviour, and effect on secondary school English and Social Studies students. [22] reported that students of mixed ability engaged in Cooperative learning improve not only in their achievement but also in their group interactions. The students exposed to the Individualized performed better than those exposed to conventional method of teaching. This difference in achievement for students taught using individualized instruction and conventional method can be attributed to the fact that the students learn at their own pace, taking their time to understand difficult materials, ask questions, and make inquiry.

Another factor that may account for the positive effect of individualized instruction is that the strategy guides learners better in their learning and assists them in recalling important information [23]. Individualized instruction, [23] further posited, is more effective in because

students had the opportunity to work together in teams during their course self-learning, share views and opinions, and engage in brainstorming on problems. Individualized learning instruction is particularly effective; when in collaboration with other approaches where the individual differences in the learners is taken care of.

The learners' individual differences may not permit all the learners to achieve the objectives of the lesson while in the class. Therefore, in individualized learning, every learner has the opportunity to study the content materials using their own style. This enables them to learn the concept very well and form their personal concept strongly related to previous knowledge. The study of chemistry demands that students be given time to learn one concept very well before going to the other. This cannot be achieved immediately in the classroom for all the learners. Thus, planning lessons in such a way that will facilitate learners learning at their own pace and an approach which will take care of the individual differences arises would always be effective. This finding of the study is supported by [24] who reported that individualized instruction had a significant effect on the students' achievement. The findings of [25] also lend credence to the findings of this study when it was noted that the use of learning activity package method of individualized instruction significantly affected students' achievement.

5. CONCLUSION

The conclusion drawn from this study is that cooperation learning positively and significantly affects students' achievement in chemistry. As an alternative to cooperative learning, individualized instruction may also be adopted given that it is also effective than the conventional method of teaching often used by chemistry teachers.

6. RECOMMENDATIONS

1. Chemistry teachers should adopt cooperative learning strategies and individualized instructions to involve students in the learning process actively and make them take more responsibility for their own learning.

2. The school administrators should provide facilities such as internets, library materials and well-equipped laboratories so that chemistry students would have enough educational resources in the course of individualized learning.

3. Frequent training on how to use cooperative learning and individualized instructions effectively in teaching and learning chemistry should be organized for chemistry teachers by the government and stakeholders in education. Such training should be supervised and evaluated to make sure that chemistry teachers have mastered the strategies for use in the classroom.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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