EFFECT OF INDIVIDUAL AND GROUP LABORATORY WORKS ON STUDENTS ACHIEVEMENTS IN SOME SENIOR SECONDARY SCHOOL

CHEMISTRY CONCEPTS

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Abstract

*The study investigated the effectiveness of group and individual laboratory works on students achievement and interest in some senior secondary chemistry concepts. Three research questions were posed and two null hypotheses which were tested at 0.05 level of significance guided the study. The study adopted a quasi-experimental design specifically referred to as the pre-test-post-test non-equivalent control group design. The study was carried out in Enugu South Education zone of Enugu State. The sample which consisted of one hundred students from one co-education secondary school were stratified in terms of group, individual and gender. The instrument for data collection was the oxygen/hydrogen achievement test (OHAT). The OHAT was face and content validated by three specialists in the area of science education. The internal consistency of the instrument was determined to be 0.65 using Kuder-Richardson Formular (20). The subjects were pre-tested before the treatment and post test was administered after the treatment. Data analysis involved the use of means, standard deviations and analysis of covariance (**ANCOVA**). The result revealed that students taught oxygen and hydrogen by working in small groups in the laboratory performed better that student taught oxygen and hydrogen by working individually in the chemistry laboratory. Again male students performed better than female counterparts both in students that worked in group and those that worked individually. Following from the findings of the study, it was recommended that the method of working collectively in small groups in the chemistry laboratory practical should be emphasized in the curriculum of pre-service teacher and chemistry students. Seminars and workshops should also be conducted for serving secondary school*

chemistry teachers so as to acquaint them with how to organize students in the chemistry laboratory for more learning of chemistry concepts.

Keywords: Students, Learning, Chemistry, Group, Laboratory works.

Introduction

The indispensable role of science, technology and mathematics in national development cannot be over emphasized. According to Jegede (1983), one would be living an unrealistic life if he is ignorant of the basic knowledge of current developments in science, technology and mathematics. Science as a discipline has touched virtually every aspect of life and conditions of living in most societies of the world (Olurndare, 1988).

As such, Science is directly or indirectly related to both the quality of life of the average individual and the economic health and security of nations at large.

Realizing the importance of science in national and economic growth, most countries of the world continue to give priority attention to science, technology and mathematics in their development efforts. For instance in Nigeria the National policy on Education (1988) emphasized science at all levels of education and redirected the entire society towards scientific thinking in order to develop new technologies and adapt existing ones to improve societal well being and security.

Chemistry is one of the basic sciences needed for a nations technological break through. The use of chemistry to manipulate the composition and behaviour of substances is also important in meeting the challenges of our complex society. To feed an expanding world population and keep it healthy is an ever-present challenge. New ways must be found to generate and use energy efficiently. Dwindling supplies of natural resources, must be replaced with other substances. Ways to recycle materials such as plastics rather than allowing them to clutter and foul our environment are needed. A good knowledge of chemistry will equip one well enough to seek and obtain solutions to the aforementioned problems (Aniodo 2001).

According to Aniodo (2001), Radio-Isotopes are used in radiotherapy in the treatment of cancer and in taking radiographs. He also had it that chemical principles and products have been utilized to control pests and weeds and in fertilizer production. It therefore follows that a sound theoretical and practical knowledge of chemistry is a pre-requisite for technological advancement in Nigeria. This

suggest why the Joint Admission and Matriculation Board (JAMB) demands a credit level pass in chemistry in West African Senior School Certificate Examination (WASSCE) for enrolment in most of the science base course.

Despite its importance, student achievement in chemistry, in WASSCE is very poor. Some research studies have been carried out to find out content areas in chemistry that students find difficult in senior secondary curriculum. According to Dawson (1978), certain topics in chemistry are too difficult until the students are able to think in a particular abstract ways, which according to piaget gradually develop with age and are little influenced by general experience. This account for why most students in secondary school learn their chemistry in a nearly rote manner. The branch of chemistry which students generally find difficult at senior secondary certificate level is physical chemistry (Eze 2002).

According to Adesoji (1986), Offiah (1987), Ezeliora (1999) and Moore (2002), poor teaching methods used by secondary school chemistry teachers have been found to contribute to poor achievement in chemistry. The poor teaching methods include traditional or conventional lecture methods. According to Aniodoh (2001), lecture method is a negation to teaching as it does not give room for effective learning but only enhances intellectual passivity and weariness of the learners. Research studies by (Resources Primer 98 Variable htm) indicated that despite much research suggesting better alternatives, classrooms still appear to be dominated by teachers' lectures and little seems to have changed in the way student are taught.

Methodology

Research design

The study is quasi-experimental design of a non-equivalent control group. The study employed a pretest, post-test, non-equivalent control design. This design is chosen as it offer less rigorous control compared to the true experimental design (Ali 1996). This design is considered appropriate since the research is geared towards finding out the effect of individual and group participation in laboratory works on students achievement in some senior secondary school chemistry concepts. The study design is represented in theTable (1) below

Table I Grouping of Students for Study

	Pretest	Treatment	Post-test
Group(Cooperative) E_1	O_1	X_1	O_1
Group (individual) E_2	O_1	X_2	O_2

Where E_1= Experimental group, group participation

E_2= Control group, individual participation

O_1= Pretest for all groups (E1 & E_2)

O_2= Posttest for all groups (E_1 & E_2)

X_1=Group participation (Treatment) given to group E_1

X_2= Individual Participation (Treatment) given to group E_2

Area of Study

This study was carried out in Enugu South Education Zone of Enugu State in Nigeria . It covered fifteen secondary schools in this zone.

Population of Study

The population of this study consisted of all year two (SSII) Senior Secondary School Chemistry students in Enugu South Education zone.

Sample and Sampling Techniques

The sample size comprised of one hundred Senior secondary Chemistry students (SSII). A simple random sampling techniques was employed to select one co-educational secondary school out of the total of fifteen secondary school in Enugu south education zone. One co-education school was used so as to avoid school difference interference. Out of the sample that was selected, the SSII chemistry students was used because they have been exposed to major aspect of chemistry topics, that the researcher used for the study. The sample selected was classified into two groups viz the experimental group that worked in groups and the control group that worked individually. This was done by a flip of a coin in order to give the two samples equal chances of being any of the above. In the school that was selected the whole streams or classes was divided into two groups, the experimental and control group to form the intact group used for the study.

Instrumentation

The instrument used for this study was oxygen/hydrogen Achievement test (OHAT). This is based on the unit in the senior secondary chemistry curriculum. It contains twenty five (25) multiple choice test items developed by the researcher. This was constructed using a table of specification representing higher and lower level of knowledge (see table for details).

Table 2: Table of specification or test-blue print on OHAT

Content &	Higher cognitive Domain	Lower Cognitive Domain	Total
Preparation of hydrogen	25	**3** Ques 2, Ques3, Ques 6	**2** Ques 1 & Ques 5	5
Physical, chemical properties & uses of hydrogen	25	**3** Ques 12, Ques 18, Ques 24	**3** Ques 10, Ques 11, Ques 22	6
Preparation of Oxygen	25	**1** Ques 13	**1** Ques 14	2
Physical, chemical Properties, & uses of Oxygen		**6** Ques 5, Ques 15, Ques 17 Ques 20, Ques 21, Ques 25	**6** Ques 7, Ques 8, Ques 9 Ques 16, Ques 19, Ques 23,	12
Total	**100**	**13**	**12**	**25**

Validation of Instrument

The instrument was face and content validated by three specialists, two in science education and one secondary school chemistry teacher. Two validators are lecturers at the faculty of Education university of Nigeria Nsukka and a teacher in Secondary School. The valdiators were requested to scrutinize the instrument along the following criteria:

- ✓ Clarity of questions asked
- ✓ Appropriateness of the questions level of understanding and experience.

If two questions tested the same concept or idea, the validators ordered that one be deleted. After the validations the instrument was amended to reflect the contributions of the validators. Out of the thirty (30) items originally produced by the researchers, five were eliminated having 25 items only (see appendix (iii) for the summary of test items)

Reliability of the Instrument

The researcher computed the internal consistency of the instrument (OHAT) using Kuder- Richardson formular (20). The choice of K-R (20) is influenced by the fact that it is best used in a multiple choice items with right or wrong answers. The reliability coefficient obtained for OHAT is 0.65 (See Appendix IV).

Experimental Procedure

The pre-test of Oxygen and Hydrogen Achievement test was administered to both groups, (the experimental groups i.e those that would work in group and the control group ie those that would work individually) on the same day by the researcher with the help of some teacher. This is to know the level of achievement of the students in the topic Oxygen/Hydrogen. Their scripts were marked and their marks recorded. The researcher carried out the experiment thereafter.

The student in the experimental group (ie those that worked in group) were taught oxygen and hydrogen. For the topic oxygen, the teacher demonstrated the experiment. She first of all prepared oxygen, by putting potassium trioxochlorate (v) and manganese (iv) oxide inside a boiling tube, she made it to stand in a deliver tube which is immersed inside a water trough where a gas jar has been inverted inside the water trough. She heated the boiling tube and a gas is given out which is collected by downward displacement of water. By the end of this lesson, the students were expected to know how to prepare oxygen. Also they were expected to know the function of each compound involved in the reaction. The teacher brought out the gas jar and carried out a test to confirm that the gas is actually oxygen. Oxygen rekindles a glowing splinter of wood. She prepared oxygen again by using hydrogen peroxide and manganese (iv) oxide (mno_2). She taught them the physical properties, chemical properties and uses. She now made available all the materials needed for preparing the gas and asked them to prepare oxygen and test for oxygen, while she supervised what they were doing.

The same experiment was done for the control group (ie those that worked individually,) but students performed the experiment by working on their own.

For the second topic that is hydrogen, she demonstrated all the experiments involved in the preparation of hydrogen. She first of all prepared hydrogen by the action of acid on metal. She put some quantity of zinc powder inside a flat bottom flask and poured

dilute Hydrochloric acid (HCl) or Tetraoxosulphate (Vi) acid(H_2SO_4). It produced effervescence and a gas was given out, which was collected by downward displacement of water. She demonstrated another method of preparation by putting water in a water trough and a piece of sodium wrapped inside a wire gauze was thrown inside the water trough . There was effervescence and a gas was given out which was collected over water.

She demonstrated the third method of preparation which was by the action of iron fillings on steam. She heated water, a delivery tube was connected inside the conical flask where the water was made to pass through combustion tube to a beaker of water where the gas jar was immersed. Steam coming out from the heated water acted on the iron fillings and hydrogen was given out and collected over water. She then tested for hydrogen. Hydrogen makes a pop sound in a burning splinter. By the end of the lesson the student were expected to know how to prepared hydrogen , and test for hydrogen. She made the students to be in group of fives. She now made all the materials needed for the preparation of hydrogen available and asked the students to prepare hydrogen and test for hydrogen while she supervised what they were doing.

The same experiment was done for the control group that worked individually, but the students in the control group demonstrated their own experiment by working individually.

The lesson plan for the experimental and control groups was written separately. The experiment was conducted during the normal periods. Within the four weeks of the experiment, the two different topics of hydrogen and oxygen was taught and covered. Each week contains a double periods of forty minutes each. This gave a total of eight periods.

Control of extraneous Variables:

To control extraneous variables the research personally carried out the teaching exercise. This eliminated the problem of teacher differences. No home work or out of class assignment was given to the students during the instructional period. The marked pre-test script was not given back to the

student before the post-test. Testing effects was also minimized by disguising the items in the instrument during post-testing. The item can be disguised by changing the numbers of the question during pre-testing.

Method of data collection

The instrument was administered on the research subject, before treatment and no feedback on the pre-test achievement was given to them. The scores of the students on pretest were recorded and kept behind for use after the treatment. At the end of the treatment, post-test was administered to the classes. For each of the groups, data for the pre-test and post-test were recorded separately. The test items were recorded separately. The test items were scored one mark each. A student scored a maximum of twenty five (25) marks and a minimum of zero.

Method of data analysis

Data on the research questions were analyzed using mean and standard deviations. Mean and standard deviation were used because mean is the most reliable measure of central tendency and standard deviation is the most reliable estimate of variability (Nworgu, 1991). The pre-test scores were used to find the gain core. A gain score is the difference between the post-test and pre-test scores of a group.

Analysis of covariance(ANCOVA) was used in testing the hypothesis, where the pre-test scores on the student's Achievement's served as covariates to the post-test scores at 0.05 level of significance. This is because the use of intact class for the study implies that initial equivalence may not be achieved for the research subjects in the two groups. In order to eliminate the errors of non-equivalence arising from non-randomization of the subject the researcher used the analysis of covariance to test the two hypotheses that guided the study, this look are of initial non-equivalence of the groups such as differences in ability level of the research subjects.

Result

Mean achievement scores of students in the oxygen/hydrogen achievement test by working individually and in group.

Table 3 Mean

	N=50 Individually group	N =50 Group work
Post-test Pre-test	13.04 8.08	18.36 8.14
Grainscore	4.96	10.22

Table 3 showed that the gainscore in the mean achievement of students taught oxygen and hydrogen in the laboratory by working in group is 10.22 while the gainscore in the mean achievement of students taught oxygen and hydrogen in the laboratory by working individually is 4.96. This showed that the student in the group laboratory work achieved higher than those that worked individually in the laboratory. To confirm whether or not the observed difference in achievement between the two groups was significant, hypothesis one was tested.

Research Question three

What is the effect of gender on students achievement as measured by oxygen hydrogen achievement test.

Table 4

Mean Achievement scores of students in the oxygen hydrogen achievement test by gender.

Sex	**Group**	**Mean**	**Std Deviation**	**N**
Male	Individual	13.6500	4.76031	20
	Group work	21.0500	4.68452	20
	Total	**17.3500**	**5.98095**	**40**
Female	Individual	12.6333	4.36667	30
	Group work	16.5667	5.32841	30
	Total	**14.6000**	**5.22121**	**60**
Total	Individual	13.0400	4.50831	50
	Group work	18.3600	5.49865	50
	Total		**5.67201**	**100**

Table 4 indicated that the mean achievement score of male student who worked in group in the oxygen hydrogen achievement test is 21.05 while the mean achievement score of males that worked individually is 13.05. The table also indicated that the mean achievement score of males that worked individually is 13.05. The table also indicated that the mean achievement score of female who worked in group in the oxygen hydrogen achievement test is 16-56 while the mean achievement score of females that worked individually is 12.63. the data generally showed that male performed better than female in the two groups.

Analysis of covariance (ANCOVA) for students mean Achievement score in oxygen hydrogen achievement score.

HYPOTHESES ONE

There is no significant difference (P<0.05) in the achievement scores of students taught by exposing them to work in group and those taught by working individually as measured by oxygen achievement test (OHAT).

Analysis of covariance for hypotheses one

Table 5

Between- subject factors

	Value label	**N**
Group 1	Individual	50
2	Group work	50

Table 6

Dependent viable post test

Group	**Mean**	**Std Deviation**	**N**
Individual	13.0400	4.50831	50
Group work	18.3600	5.49865	50
Total	15.7000	5.67201	100

Table 2

Levene's Test of equality of error variances dependent variable**:** post test

F	df_1	df2	sig
4.367	1	98	0.39

Test the null hypotheses that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Pretest + Group

Table 8

Test of Between subject effects

Dependent variable: Post test

Source	Type III Sum of Square	Df	Mean square	F	sig
Corrected model	1093.025[a]	2	546.513	25.3411	.000
Intercept	2655.988	1	2655.988	123.152	.000
Pretest	385.465	1	385.465	17.873	.000
Group	699.668	1	699.688	32.442	.000
Error	2091.975	92	21.567		
Total	27884.000	100			
Correct total	3185.000	99			

a R squared= 343 (Adjusted R=.330)

The result in Table 8 showed that the calculated f-ratio due to group is 32.442 while the critical f-ratio has a value of .000 at 0.05 level of significance. Since the Calculated f-ratio is greater that f-critical (32.442> 0.000) the researcher therefore rejected the null hypotheses and concluded that there is a significant difference (P<0.05) in the achievement scores of students taught by exposing them to work in group and those taught by working individually as measured by oxygen hydrogen achievement test (OHAT).

HYPOTHESES TWO

There is no significant difference in the mean achievement scores of male and female students taught Chemistry using group laboratory work approach.

Analysis of Covariance for Hypotheses Two

Table 9

	Valued lablel	N
Sex 1.00	Male	40
2.00	Female	60
99		

Table 10

Test of Between-Subjects Effects

Dependent Variable –Post-test

Source	Type III Sum of Square	Df

Corrected model	490.021[a]	2	244.011	8.819	.000
Intercept	2719.895	1	2719.815	97.897	.000
Pretest	308.521	1	308.521	11.105	001
Sex	96.664	1	96.664	3.479	.065
Error	2694.999	27	27.783		
Total	27834.00	100			
Correct total	3185.000	99			

a R squared- 154 (Adjusted R=.136)

The ANCOVA Table indicated that the calculated f-ratio due to gender (3.479) is greater than critical (.065) at 0.05 level of significant. The researcher therefore rejected the null hypotheses hence there is a significant difference in the mean achievement scores of male and female students as measured by OHAT.

Further investigation on the ANCOVA table, revealed that there is a significant difference in the mean achievement scores of students who worked in group and students who worked individually as measured by oxygen hydrogen achievement test. This result tends to suggest that students who worked in group in the chemistry laboratory had a better grip of the concepts and principals taughts than their counterpart who worked individually. This findings is in line with the view of Umeoduagu (2000) who opined that the way a leaner learns depends on the way learning materials is presented to him. Again it agrees with opinion of Onwuka (1984) who argued that the method adopted by a teacher is important since it has power to either enhance or inhibit learning. The finding also strengthens the advocation of Adesoji (1986) to shift from traditional method of teaching to innovative and self learning devices.

Discussion of Findings

The result in Table 3 showed that the students taught oxygen and hydrogen in the laboratory by working in group had a mean gainscore of 10.22 while the students taught hydrogen in the laboratory by working individually had a mean gainscore of 4.96. This tends to imply that students that worked in group in the laboratory achieved higher than their counterparts who worked individually in the laboratory

The finding is consistent with the empirical study carried out by Nnaka and Anaekwe (2003) on the effects of student's learning styles (SLS) gender and their interaction effect, on the achievement and retention of chemistry concepts. The result of this study would appear to indicate that the student's learning styles (SLS) had a significant effect on students achievement and retention of chemistry concepts. Specifically, the cooperative learning

style is more predisposing to achievement and retention of chemistry concepts relative to the other learning styles. This was followed respectively by the competitive and individualistic learning strategies.

The findings also aggress with the views of Johnson and Johnson (1983) who said that a possible explanation for this result above could be abduced from the quality of their reasoning habits. The team approach to learning according to Johnson and Johnson enhances higher quality cognitive strategies for learning and meta-cognitive thinking than the other groups. This meta-cognition enhances the storage of information in the memory and long-term result of such information.

The superior mean achievement and retention scores of the competitive and individualistic groups relative to control group, could be explained on the basis of the active mutual involvement of the learners in their respective strategies.

The findings agrees with the studies of middle-school biology students in Nigeria by Peter Okebukola and his colleagues (1986, 1992) in which the teachers were randomly assigned, carefully trained and observed during the course of their teaching. Their result show that student who preferred cooperative learning benefited most from it, that cooperative learning is a powerful way to help students develop favourable attitudes towards laboratory work and that although students in a competitive environment were best at learning practical laboratory skills, those in a cooperative learning environment score higher on cognitive achievement in science. Finally, the finding of this study conforms with the study of Humphrey, Johnson & Johnson (2006) who explored the effect of cooperative, competitive and individualistic learning on student achievement in science class. Forty four students were included in the study. Students were randomly assigned to conditions stratifying for sex. The results indicated that cooperative learning experiences promoted greater mastery and retention of material being taught as well as more positive attitudes towards the experience than did competitive & individualistic learning experiences.

However, the finding contradicts the view of Ali (2001) who reported that no one method of teaching can be regarded as the best for every teaching situation. It also disagrees with the view of Swan (1989) who argued that teaching method adopted by a teacher has no effect on the acquisition of science process skills. But Okorie (1979), suggested that a combination of teaching methods should be

adopted for teaching chemistry as according to him a carefully designed teaching methods can work wonders in making learning effective. Again the findings of this study contradicts the report by Ogbebor (1986) who carried out a comparative study on the performance of secondary school students taught by expository and programmed instruction methods in geography. A sample of 80 students was used in Ika L.G.A of Bendel State. Data on students' achievement was analyzed using the t-test. The reliability coefficient of the instrument was not estimated. The result of this study showed that there was no significant difference between the mean score of student taught with programmed instruction and those taught with expository method.

The use of t-test as a method of data analysis in the work of Ogbebor (1986) was not justifiable because intact classes were used for the study. The use of intact classes implied that the two groups were not equivalent. Analysis of covariance (ANCOVA) would have been used in analyzing data on the hypotheses so as to take care of the initial non-equivalence of the two groups. The generalizability of the study was limited because the work had no reliability estimate.

Kuder-Richardson formula (20) K-R (20) would have been used in computing the reliability coefficient.

Effect of Group Lab work on Mean achievement of Male and Female students in chemistry

Table 4 indicated that male students in the oxygen hydrogen achievement test who worked in group had a mean gainscore of 21.05 while their female counterparts who worked also in group had 16.56. The same table also indicated that male students who worked individually had a mean gainscore of 13.05 while their female counterpart had 12.63. Table 4 therefore showed that male students in the oxygen hydrogen achievement test who worked in group achieved better than their female students that also worked in group. Secondly, that male students who worked individually achieved better than female students who worked individually in the oxygen hydrogen, achievement test.

Further investigation in Table 10 showed that the calculated f-ratio due to gender (3.479) is greater than critical f-ratio (0.65) at 0.05 level of significance. The researcher therefore rejected the null hypotheses. The difference in the mean achievement scores of male students when taught oxygen hydrogen by working in group and female students who also worked in

group is statistically significant. The finding is in line with the view of Lassa(1995) and Hacker (1992) who maintained that gender discrepancies exist in the school curriculum for boys and girls. It is also consistent with findings by Akusoba and Ezike(1991) Brien and Porter(1994) and Mama (1995) who found significant gender differences in favour of males in biology physics and agricultural science respectively: It however contrasts with report by NKpa (1997) who found significant gender difference in favour of girls in agricultural science. Moreover, the finding contrasts with Maduabum (1995) and Eya and Mgboh (1997) who observed no significant gender difference in achievement of male and Female students.

Conclusion

This study has revealed that the use of group work in the laboratory during chemistry practical has enhanced students achievement in chemistry . Student who were taught oxygen and Hydrogen by working in small groups achieved significantly higher than those who were taught the same Hydrogen and Oxygen by working individually. Secondly, male students who worked in groups in the laboratory performed better than female students that also worked in group in the laboratory. This indicate that gender discrepancies exist in the school curriculum for boys and girls.

Recommendation

Based on the educational implication mentioned above the following recommendation are made;

1. Since the efficacy of working collectively in small groups in the chemistry laboratory practicals has been established the method should be emphasized in the curriculum of pre-service teachers and secondary school chemistry students. This is to acquaint student teacher and chemistry students with its use and hence make chemistry learning process more effective.

2. Existing teacher should be compelled not to dominate the chemistry laboratory classes with demonstration method alone. They should allow active involvement of the students while chemistry laboratory lesson is going on. This will give students freedom to satisfy curiosity and inquiry mind. This can be done by the constant checking of the chemistry teacher by educational authority with the aim of plugging all

the loopholes that might hinder the teaching and learning

3. Teachers should be motivated so as to bring out the best in them. This could be done by paying their salaries and allowances. Again seminars, conferences and workshops should be organized by government agencies and professional bodies such as Science Teacher Association of Nigeria (STAN) to educate the already serving teachers on the proper way to organize and control students during practical lesson so as to bring out the best in them.
4. Curriculum planners and teachers should find measures that should be taken so as to bridge the gaps that leads to gender differences in the understanding of chemistry concepts.
5. Since it is necessary that students should be handling laboratory apparatus. The federal government should provide funds for equipping laboratories because without proper and adequate laboratory equipment teachers cannot carry out practical work effectively. Also teachers should be motivated in order to improvise some materials when necessary. Again each science subject should have a separate functional laboratory.

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