Extent of Integration of Practical Work in the Teaching of Chemistry by Secondary Schools Teachers in Taraba State

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Abstract

This study investigated the extent of integration of practical work in the teaching of chemistry by secondary school teachers in Taraba State, Nigeria. It was guided by three research questions and three null hypotheses. The study adopted descriptive survey design. Stratified random sampling was used to select 45 out of 76 chemistry teachers in the 76 secondary schools. A questionnaire constructed by the researcher which consists of 22 items, drawn on five-point scale was used to collect data for the study. Validation of the research instrument was carried out by three experts from the Department of Science Education and reliability established using Cronbach Alpha which yielded a coefficient value of 0.81. Data for the research were collected through self-administered questionnaire by the researchers and the two assistants. The analysis of the data was done using mean and standard deviation to answer the research questions while the null hypotheses were tested at 0.05 alpha levels with One-way analysis of variance. The findings revealed that the extent of integration of practical work in the teaching of Chemistry by secondary schools teachers in Taraba State is low and this was influenced by teachers' qualification. The study recommended among others that chemistry teachers should ensure frequent integration of practical work in the teaching of topics in chemistry using appropriate methods.

Key words: Integration, Practical work, Teaching, Chemistry**.**

Introduction

Chemistry deals with the composition, properties and uses of matter. It probes into the principle governing the change that matter undergoes. Our world is made up of matter (anything that has mass and can occupy space) thus we study chemistry to acquire knowledge about matter and perform experiments to learn, observe, record and make intelligent inferences. Studying chemistry gives us training in the scientific method. Chemistry has become one of the most important science disciplines in the secondary school curriculum. At secondary school

level, chemistry is taught through theory as well as practical which involve experimentation and demonstration to explain concepts. The study of chemistry as a science subject in senior secondary schools entails the exposure of learners to both theoretical and practical aspects of learning experiences. The methods of instruction vary depending on the nature of the content. Some content involves theory work while others involve practical work.

The conventional method of teaching chemistry in the secondary schools entail that theory aspect is taught in the classroom while practical aspect is taught in the laboratory. However, this method gives more priority to theory aspect and also it might seem difficult for students to relate or transfer the knowledge obtained in a theoretical class to a practical class or vice-versa. Ejedike and Oyelana (2015) found out that practical work is handled negligently or based on chemistry teachers' conveniences. This neglect, according to Adesoji and Arowosegbe (2015) makes chemistry difficult for learners and consequently, they perceive chemistry as a difficult and abstract subject. Njoku (2007) equally attributed descending differential achievement of students in chemistry in quantitative analysis, qualitative and theory of practical questions to wrong way and manner teachers teach practical chemistry. For proper understanding of the chemistry as a subject there is a need for integration of practical work in the teaching of chemistry by teachers. Integration is the act of bringing together smaller components into a single system that functions as one (Rouse, 2015). It can be seen as an act of combination, inclusion or bringing in of practical work into the teaching and learning of chemistry for better understanding of the phenomena or concepts that seems to be abstract to students. To remove the abstract nature of chemistry, integration of practical work is necessary in the secondary school syllabus of chemistry.

The West African Examination Council Syllabus (WAEC, 2016) recommended that the teaching of chemistry should be practical-based and that students should: have the understanding of basic chemistry concepts, acquire laboratory skills, be aware of the inter-

relationship between chemistry and other disciplines and be aware of the linkage between chemistry and industry/ environment /everyday life in terms of benefits and hazards; and skills of critical and logical thinking. This is to demonstrate the importance of practical work in chemistry. The practical experience constitutes an integral part of chemistry because the subject consists of many topics that can be verified experimentally with an objective to create an enabling environment to stimulate students learning about chemistry that is commonly presumed as abstract, quantitative and boring (Read & Kable, 2007). When practical work is not properly integrated in the teaching of chemistry, it will surely show in their academic performances. The Chief Examiner's report on practical chemistry (2015) indicated that the inadequacies in students' performance was attributed to the following weaknesses; non-adherence to rubric, arithmetical errors in volume of acid-used, averaging non-concordant value, poor mathematical skills; poor knowledge of S.I units of mass concentration and molar concentration, tests of solids instead of solutions among others. These weaknesses may be as result of negligence of teachers to integrate practical work or the integration of practical work is done by teachers that are not professionally qualified to teach chemistry.

Abe and Adu (2013) opined that teacher's qualification / teaching qualification, is one of a number of academic and professional degrees that enable a person to become a registered teacher in primary or secondary school. Such qualification includes but not limited to the postgraduate diploma in education (PGDE), professional diploma in education (PDE), Bachelor of Education (B.Ed.), Bachelor of Science Education (B.Sc. Ed), Bachelor of Art Education (B.A. Ed) and national certificate in education (NCE). In Taraba State teachers who are academically qualified or are professionally qualified are engaged to carry out instructional process. Academically qualified teachers refer to those who have academic training as a result of enrolment into educational institution and obtained qualification such as HND, B.Sc., B.A, M.A, and so on while professionally qualified teachers are those who got professional training

that gave them professional knowledge, skills, technique, aptitude as different from the general education (Edu & Kalu, 2012). A teacher is someone who has been exposed to a good measure of training in a teaching subject areas as well as professional education. One thing is to be well grounded in the conceptual understanding of a subject; another thing is to be well equipped with the best method to pass the concepts across to the learners for proper comprehension. A professional teacher would be desirable in this regard.

According to Ikeobi (2010), it is the teacher who organizes the interactions between the subject (learner) and the object (learning materials). It is the teacher who ensures that equipment and materials are properly used by the learner to achieve the expected objectives. All these point to the fact that teacher is a very significant factor when the learners failed to exhibit the expected mastery in a science subject like chemistry. Owalobi (2012) found out that students' perform better when taught by professional teacher than when taught by non-professional. Many other researchers such as Akinsolu (2010), Ouma (2011) and Njoku (2015) also found out that teacher's qualifications influence students' academic performance.

The Chemistry Chief Examiner's report (2015) revealed that there is an increase in lack of understanding, comprehension and assimilation of chemistry as a science subject. This may be as a result of who teaches chemistry and how has it been taught. For the in-depth understanding of the subject as majority of the concept in chemistry seem to be abstract, students require practical classes organized by professionally qualified teacher that will help the students to visualize what they have been taught in a theoretical class. Many factors have been identified as responsible for lack of understanding and poor performance of students in chemistry; these are inadequate resources both human and material, curriculum related impediment and lack of laboratory work among others. In view of the several suspected factors mentioned as the reasons responsible for the continued students' poor performance in

chemistry, this study sought to investigate extent of integration of practical work in the teaching of chemistry by secondary schools in Taraba state.

Research Questions

1. To what extent are topics integrated into practical work by secondary school teachers in teaching of chemistry based on their qualification?
2. What types of instructional methods are used in integration of practical work in the teaching of chemistry by secondary school teachers based on their qualification?
3. What is the frequency at which these practical works are integrated in the teaching of chemistry by secondary school teachers based on their qualification?

Hypotheses

The following null hypotheses were tested at 0.05 levels of significance:

1. There is no significant difference in the topics integrated into practical work by secondary school teachers based on their qualifications.
2. There is no significant difference in the extent of instructional methods used in practical work integration by secondary school teachers based on their qualifications.
3. There is no significant difference in the frequency at which these practical works are integrated in the teaching of chemistry by secondary school teachers based on their qualifications.

Method

The study adopted descriptive survey as research design. The population of the study comprised all chemistry teachers in all public secondary schools in Taraba State, Nigeria. There are 76 chemistry teachers in public secondary schools in Taraba State. The sample for this study consists of 45 chemistry teachers selected from 45 out of 76 schools in Taraba state. The stratified random sampling was adopted to select 45 secondary schools and 45 chemistry

teachers of the state. Data for the research study were collected through self-administered questionnaires to ensure fairness, objectivity, and for explanation on unclear issues in the questionnaire. The instrument was validated by experts in Department of Science Education from Nnamdi Azikiwe University Awka. To test for reliability, a trial study was carried out in two secondary schools in Adamawa state which were not part of the sample used. The researcher administered the questionnaire to six (6) chemistry teachers in three secondary schools. The reliability coefficient was 0.81 using Cronbach Alpha.

The data related to research questions were analysed using mean and standard deviation. A mean rating of 3.00 and above was indicated agreement with the item while a mean rating below 3.00 indicated disagreement with the item. The null hypotheses were tested at 0.05 levels of significance using one-way ANOVA.

Results

Table 1: Mean Ratings of Teachers on the Extent Topics are Integrated into Practical Work in the Teaching of Chemistry based Qualification

S/N	Topics	NCE (N=24)		Graduate (N=14)		Postgraduate (N=7)		Total (N=45)		Decision
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1.	Standard separation technique	4.92	.27	3.92	1.42	3.92	1.12	4.39	1.14	Agree
2.	Solution of acids and base	4.84	.37	4.21	1.51	4.44	.53	4.43	1.15	Agree
3.	Water of crystallization	2.14	.41	2.10	.52	2.81	1.41	2.11	.37	Disagree
4.	Solubility of acids and bases	2.84	.54	3.42	1.20	3.52	1.02	3.68	.97	Agree
5.	Percentage purity	2.41	.78	2.10	.50	2.53	.70	2.21	.66	Disagree
6.	Stoichiometry reaction	2.52	.85	2.24	.82	2.42	.48	2.32	.84	Disagree
7.	Redox reaction	2.44	.84	2.82	1.12	4.73	.37	3.11	1.05	Agree
8.	Halogens displacement	2.39	.85	2.43	1.01	3.72	.36	2.59	.93	Disagree
9.	Gases and functional grps	2.64	1.0	2.45	1.42	2.64	.37	2.53	1.29	Disagree
10.	Rxn of acids on solid or aqueous solution	4.45	.94	3.83	1.51	4.13	.70	4.14	1.29	Agree
11.	Rxn of cation with base & alkali	4.25	.44	3.52	1.42	4.52	.37	3.87	1.10	Agree
12.	Determination of PH, rates of rxn and eqll. Constant	2.29	1.1	3.51	1.35	4.61	1.01	3.85	1.91	Agree
13.	Measurement of mass & vol., heat of neutralization	4.13	1.0	3.44	1.43	4.32	.37	3.74	1.32	Agree
14.	Use of indicators to determine conc	4.92	.27	4.12	1.61	5.10	.48	4.46	1.21	Agree

Table 1 indicates that from the fourteen topics selected for this study in which practical work are supposed to be integrated while teaching the topics, NCE holders integrate practical work in six topics with mean rating above 3.00 points and do not integrate practical work in eight topics with mean rating below 3.00. Graduates integrate practical work in eight topics and do not integrate practical work in six topics against postgraduates that integrate practical work in ten topics and do not integrate in four topics. Generally, secondary school teachers under this study integrate practical work in teaching only nine topics with mean rating above 3.00 and neglected integration of practical work in teaching five topics with mean rating below 3.00 regardless of their qualification.

Table 2: Mean Ratings of Teachers on the type of Instructional Methods used in Practical Work Integration in the Teaching of Chemistry Based on Teachers Qualification

SN	Methods	NCE (N=24)		Graduate (N=14)		Postgraduate (N=7)		Total (N=45)		Decision
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
15.	Teacher demonstration	4.17	1.03	13.9	1.53	4..81	.37	4.09	1.21	Agree
16.	Group method	3.98	1.52	4.06	.49	4.19	.37	4.04	1.52	Agree
17.	Individualized method	1.41	.49	2.64	1.31	3.24	1,32	2.17	1.23	Disagree

Table 2 reveals that most of NCE holders and graduates prefer teacher's demonstration and group methods in performing practical work with mean rating above 3.00 as against individualized method which has mean rating below 3.00 but postgraduates uses all the three instructional methods. However, teacher demonstration and group methods are generally used as a method of integration of practical work among secondary school teachers irrespective of their qualifications with mean rating above 3.00 as against individualized method with mean of only 2.07. This implies that acquiring of practical skills may be difficult for students under the study area since teachers give more emphasis on only two instructional methods as against three.

Table 3: Mean Ratings of Teachers on the Frequency at which Practical work are integrated in the Teaching of Chemistry based on Teachers' qualification.

S/N	Frequency	NCE (N=24)		Graduate (N= 14)		Postgraduate (N=7)		Total (N=45)		Decision
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
18.	I never perform practical work	1.62	.51	1.07	.00	1.25	.50	1.37	.48	Disagree
19	I rarely perform practical work	1.62	.51	1.07	.00	1.25	.50	1.37	.48	Disagree
20	I occasionally perform practical work	4.14	.89	4.05	.94	3.81	.96	4.02	.89	Agree
21	I often perform practical work	1.81	.81	3.76	.92	3.06	.04	2.74	1.2	Disagree
22	I always perform practical work	1.71	.70	3.05	.47	3.07	.05	2.33	.87	Disagree

Table 3 indicates that all secondary school teachers regardless of their qualifications disagree with the statement that they never or rarely perform practical work while teaching chemistry with mean ratings below 3.00. All respondents perform practical work occasionally while teaching chemistry with mean above 3.00 but only Graduates and Postgraduates do perform practical work often and always. However, the total means of often and always performs practical work among secondary school teachers is below 3.00 suggesting that practical work is perform occasionally among secondary school teachers.

Table 4: One-way Analysis of Variance of Difference between Mean Ratings of Teachers on the Topics of Integration and Teachers' Qualification

	Sum of Squares	Df	Mean Square	F	P-value	Dec
Between Groups	138.163	2	69.081	13.661	.000	Sig
Within Groups	136.538	42	5.057			
Total	**274.700**	**44**				

Table 4 reveals that the difference between topics of integration of practical work and the teachers' qualification is significant since the p-value is less than 0.05 hence the null hypothesis is rejected. This implies that teacher qualification plays a significant role on the choice of topics to integrate practical work in the teaching of chemistry.

Table 5: One-way Analysis of Variance of Difference between Mean Ratings of Teachers on the type of Instructional Methods used in Practical Work Integration and Teachers' Qualification.

	SS	Df	Mean Square	F	P-value	Decision
Between Groups	21.317	2	10.658	25.609	.000	Sig
Within Groups	25.530	42	.939			
Total	**46.667**	**44**				

Table 5 indicates that the p-value is less than 0.05 therefore there is a significant difference in the type of instructional methods used in practical work integration and teachers qualification, so the null hypothesis is rejected.

Table 6: One-way Analysis of Variance of Difference between Mean Ratings of Teachers on the Frequency of Integration and Teachers' Qualifications

	Sum of Squares	Df	Mean Square	F	P-value	Remark
Between Groups	41.131	2	20.566	31.222	.000	Significant
Within Groups	182.455	42	.659			
Total	**223.586**	**29**				

In Table 6, the result shows that there is a significant difference between the frequency at which practical work is integrated in the teaching of chemistry and the teachers' qualification seeing that the p-value is less than 0.05. Therefore, the null hypothesis is rejected.

Discussion

The result of the findings for research question one revealed that there is a significant difference between teachers' qualification and the topics of integration of practical work in the teaching of chemistry. As shown in Table 1 where NCE holders integrate practical work in only six topics out of fourteen, graduates integrate practical work in only eight topics and postgraduate integrate practical work in ten topics. It was also revealed that teachers generally integrate practical work in only nine of the fourteen topics. This however will have effect on the students because the topics have been taught half way, and according to Adesoji and

Arowosegbe (2015), it will make chemistry difficult for learners and consequently they will perceive chemistry as a difficult and abstract subject.

This finding is in line with the findings of Owolabi (2012) who found out that students performed better when taught by professional teachers than when taught by non-professional. This implies that to be academically qualified is not enough reason for somebody to teach chemistry but to be professionally qualified can give someone knowledge and skills to teach. This is because further probing shows that most of these graduates do not have teaching qualification but academic qualifications and so the knowledge required to integrate practical work in all the stated topics might not be there. Likewise, Akinsolu (2010) found out that teacher qualification was significantly related to students' academic performance.

The findings for research question two revealed that teachers' qualification has great influence on the type of instructional methods used in practical work integration in the teaching of chemistry. Indication showed that NCE and Graduates prefer teachers' demonstration and group methods as against all the three methods used by postgraduates. This was established by Njoka (2015) that the main activities observed in the laboratories by many teachers were teacher demonstrations. Though Njoka believed that when group practical are used, the number of students per group is unusually big, therefore the individual practical will not be possible in the large class size. The use of various instructional methods in integrating practical work helps to develop students' practical skills and improve their performance as discovered by Ouma (2011) who found teaching methods as one of the factors that influences student performance positively.

Though, the least popular, individualized methods are the best because it gives the students an opportunity to have hands on experience with the apparatus and chemicals. It also gives them confidence and exposure. This is very important because in the final exam they do

the practical individually. Millar (2004) observed that the students must play an active role in the learning process if he has to make sense of ideas and concepts presented during the lesson. This is inevitable for any practical lesson to be meaningful.

Other studies that agree with the finding include Njoku (2007), Adesoji and Oluwatobosun (2008). Although, majority of the practical work should be individualized method, the general usefulness of demonstrations and group methods must be stressed, for they are effective and economical in supplying knowledge, and they are particularly valuable in coordinating a series of facts, or in repeating a well-known historical experiment, and time must be allowed for their inclusion

The findings of research question three revealed that there is a significant difference between the teacher qualification and frequency of integration of practical work in the teaching of chemistry by teachers. From the result, all NCE holders disagree with the statement that they never or rarely perform practical work while teaching chemistry with a mean rating below 3.00 but all of the agree that they occasionally perform practical work and disagree that they often or always perform practical work while teaching chemistry. Graduates and postgraduate disagree with the statement that they never or rarely perform practical work but agree that they occasionally, often times and always perform practical work. However, even though all the teachers disagree that they never or rarely perform practical work while chemistry, but generally agree that practical work is occasionally being performed in the teaching of chemistry. Therefore, it implies that the frequency of integration of practical work is low. Ojelade (2015) found out that frequent practical lessons help develop practical skills in the leaner, makes chemistry more meaningful to the learner, promotes systematic reasoning and predictive ability in students and makes the learners to see the practical use of chemistry theories in everyday life. Based on the finding of Ojelade, students in Taraba State are liable

of having limited knowledge of chemistry since the frequency of integrating practical work is low.

Conclusion

Based on the findings of the study, it was concluded that the issue of personnel is important in integrating practical work in the teaching of chemistry as most of the teachers handling the subject are not professional on the job, though they are graduates. Some of the teachers teaching chemistry in secondary schools will not be as effective as a specialist in the subject itself due to inappropriate educational qualification to teach the subject and this is what operates in most of the schools under study.

Recommendations

Based on the findings of this study, some recommendations were made for effective integration of practical work in the teaching of chemistry which includes:

1. Chemistry teachers should try as much as possible to integrate practical work in topics taught in theoretical class for better understanding of the concepts.
2. Chemistry teachers should ensure that students are taught practical using different methods especially individualized and/or group methods. Teacher demonstration should be used only when the experiment is dangerous, apparatus are expensive and complicated for the learner, or when the time and apparatus are limited.
3. Chemistry teachers should frequently integrate practical work in their teaching of chemistry to remove the abstract nature of chemistry concepts/theories and as well develop student's practical skills.

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