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Effect of Microscale experimentation approach on chemistry students' attitude towards electrolysis

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Abstract
This study aimed at determining the effect of Microscale Experimentation Approach on Chemistry students' attitude when taught the concept of electrolysis. Two research questions and one hypothesis guided the study. A pre-test, post-test non-randomized quasi-experimental design was used. One thousand seven hundred and fifty-six (1,756) Senior Secondary II Chemistry students (2017/2018) academic session made up the population while one hundred and twelve (112) students were the sample of the study. The sample size was drawn using the Purposive sampling technique. The research instrument developed for the collection of data was Students Attitude towards Electrolysis Concept (SAEC). The questionnaire has a total of forty (40) items in Likert type, with four sub-sections. The internal consistency of the instrument was established using Cronbach alpha and the reliability coefficient of 0.76 was obtained. Data were collected and analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The findings of the study revealed that microscale experimentation approach has a positive and significant effect on students' attitude towards electrolysis concept. It also showed that gender is not a major factor that influences students' attitude towards electrolysis as both male and female Chemistry students had their attitude influences positively. It was recommended that Chemistry teachers should utilize this approach in teaching the concept of electrolysis in order to develop in students, positive attitude that invariably enhances their performance.

Keywords: microscale experimentation, attitude, electrolysis, chemistry

Introduction

The transformation of the global economy is a major drive for individuals in this 21st century and Science particularly Chemistry is a viable tool for such transformation. Chemistry is central to natural Science and often referred to as the "Central Science". Aniodoh and Eze, (2014) [5] described Chemistry as a branch of Science which enables students to understand what happens around them; it affords students the opportunity to explore their immediate environment. Therefore, Chemistry education has an important role in helping students find answers to various human and socio-economic problems as well as develop a more scientifically literate society (Delmang & Gongden, 2016) [7]. As such, the revised Chemistry curriculum for senior secondary schools in Nigeria was developed with contents that will enhance students' interest and have a positive attitude towards Chemistry as a subject. This is aimed at developing functional citizens that can contribute to the quality of life and sustainable national development. The formation of a positive attitude towards Chemistry by students enhances their performance as observed by Gongden (2015) [9], who in his findings enumerated several factors responsible for students' poor performance to include students and Chemistry teachers' misconception and most importantly students' attitude towards Chemistry.

Studies have shown that there is a correlation between students' attitude and their academic performance (Nadji, 2013). Ackey (2006) [3] affirmed this in his study that students' attitude can contribute to their performance. Similarly, Adesoji, (2008) [7] enumerated several factors that can contribute to students' attitude towards the learning of Chemistry. This includes the method of instruction, the attitude of the teacher, students' career interest etcetera. It is pertinent to emphasize the importance of the teacher's positive attitude towards positive attitude development in students. Bauer (2002) [6] affirmed that teachers' enthusiasm, effectiveness and experimentation influences students' attitude positively. Attitude is an essential factor that influences human behaviour and students learning in particular. It is the positive and negative feeling about an issue. The attitude of the student towards Science and Chemistry, in particular, involves affective behaviour. Attitude is simply a way of thinking exhibited by an individual. Oluwatelure and Oloruntegebe (2010) [12] opined that ''attitude is a concept, which arises from the attempt to account for the observed regularities in the behaviour of individual persons, the quality of which is judged from the observed evaluative responses one tends to make''. The development of a positive attitude towards Chemistry is one of the vital goals of Science. Therefore, a unique way that can contribute to the development of positive attitude and cognitive growth is the use of experimentations such as the microscale experimentation approach which when organized effectively has great potentials to enhance social interactions and develop positive attitude in students. Microscale experimentation approach entails the use of chemicals in small quantities. It is a shift from the conventional experimentation approach of using laboratory glass wares to using plastic materials without compromising the quality and standards of chemical applications. In using this approach, students are introduced to new sets of learning materials they are familiar with and can easily be handled by them. Hence, their interest is aroused and they are motivated to learn and invariably attain positive attitude that can enhance their performance.

Students' negative attitude towards Science is connected to

the traditional approach of Science learning while a positive attitude and feeling towards Science are connected to a constructivist learning approach (Hacieminoglu, 2016). Therefore, the key to improving the performance of students is effective teaching that sustains students' interest by relating new concepts to student's foundational facts and experiences. Hence, the role of the Chemistry teacher is to utilize practical activities that can make the learning process have a connection between theoretical ideas and realities. The studies by Farhana and Zainu, (2012) [8] revealed that students feel happy when they carry out experiments or involved in practical activities. This is because using experimentation approach in teaching Chemistry provides more detailed information about Chemistry and in turn enhances students' interest to learn Chemistry. Therefore, this study aimed at investigating the influence of microscale experimentation approach on students' attitude towards Chemistry

Statement of the Problem

Student's behaviour is a product of his attitude (experiences). As such, students with positive experiences and attitudes are influenced by their teachers' positive attitude and teaching process (Bauer, 2002) [6]. This implies that the priority of every Chemistry teacher is to help students develop interest and positive attitude toward Chemistry as a subject. This is because students with a positive attitude tend to be more attentive during instruction and participate more actively in scientific learning activities which invariably enhance the learning of scientific concepts and skills acquisition resulting to higher achievement (Akcay, Yanger, Iskander & Turget, 2010). Abulude (2009) [1] in his findings stated that the attitude of students towards Chemistry is not satisfactory. This was collaborated by the studies of Farhana and Zainu, (2013) [8] which observed that most students have a negative attitude towards Chemistry as revealed in the result of their findings that 36.2% of the students prefer Chemistry to any other subject while 63.8% have a negative attitude towards Chemistry as they prefer other subjects to Chemistry. However, the use of practical activities or experiment helps students develop a positive attitude towards Chemistry as indicated by Farhana and Zainu, (2013). Thus, the question now is how can Chemistry students be taught chemical concept like electrolysis such that their attitudes towards Chemistry can be influenced positively?

Aim and Objectives of the Study

The main aim of this study was to examine the effect of microscale experimentation approach on students' attitude towards the learning of electrolysis concept in Chemistry. It specifically seeks to:

1. Determine the attitude (pre-attitude and post-attitude) of Chemistry students exposed to microscale experimentation approach and those taught with lecture method towards the learning of electrolysis concept.
2. Examine the effect of gender and method on students' post- attitude towards the learning of electrolysis concept.

Research Question

The following research questions were developed to guide the study

1. What is the attitude (pre-attitude and post-attitude) of Chemistry students exposed to microscale experimentation approach and those taught with lecture method towards the learning of the concept of electrolysis?
2. What is the effect of gender and method of teaching on students' post- attitude towards the learning of the concept of electrolysis?

Hypothesis

The null hypothesis was tested at 0.05 level of significance:

1. There is no significant difference in the attitude (pre-attitude and post-attitude) of Chemistry students exposed to microscale experimentation and their counterparts taught with lecture method.

Research Design

The study employed a quasi-experimental pre-test, post-test non-randomized design which involved two groups; experimental and control group. Students in the experimental group were exposed to microscale experimentation approach while students in the control group were taught with lecture method.

Sample and Sampling Technique

The sample of the study was one hundred and twelve (112) senior secondary (II) Chemistry students in Port Harcourt Local Government Area of Rivers State. Purposive sampling technique was used considering the characteristics of interest to the researchers. Two schools with a mixed population of male and female Chemistry students were used. Similarly, the Chemistry teachers involved have taught Chemistry for at least five years. The sample of the study comprised sixty-seven (67) males and forty-five (45) females.

Reliability Instrument

The instrument used for the study was a questionnaire tagged Students Attitude towards Electrolysis Concept (SAEC). This was developed to measure students' attitude towards the concept of electrolysis. The questionnaire has a total of forty (40) items in a modified scale divide into three sub-sections namely: Students' Attitude towards Electrolysis Concept, Students Attitude towards the Method of Teaching Electrolysis, and Students' Attitude towards the Chemistry Teacher. The rating scale was based on four points: High Extent (4), Moderate Extent (3), Low Extent (2), and Very Low Extent (1). The Students' Attitude towards Electrolysis Concept (SAEC) was administered to one of the schools outside the two schools selected for the study. This employed a test-retest method to determine the measure of the stability of the instrument. The internal consistency was established using Cronbach alpha and the reliability coefficient of 0.76 was obtained.

Experimental Procedure

The researcher with the permission of the school principals worked with the SS (II) Chemistry teachers, technicians and the laboratory attendants of the selected schools as research assistants. This study was carried out during a five-week course on Electrolysis as described in the secondary school Chemistry curriculum**.** Two groups (after pretested) were used for the study: one experimental group and one control group. The researchers with the assistance of the Chemistry teachers, laboratory assistants and technicians of the selected schools taught each sub-topic per week for five weeks using the validated lesson plans. The experimental group was exposed to the Microscale Experimentation Approach while lecture method was employed in the control group. Students

in the control group were taught without any practical activities but with pictures of the experiment, however, students in the experimental group were taught the concept of electrolysis of Sodium tetraoxosulphate (VI) in purple cabbage extract (purple cabbage extract served as an acid-base indicator) using microscale experimentation approach; students constructed an improvised plastic syringe Hoffman's Apparatus for the electrolysis of Sodium tetraoxosulphate (VI) as described by the researchers. The sixth week was for the administration of the post-attitude questionnaire.

Data Analysis

The data collected were analyzed using mean scores, standard deviation and Analysis of Covariance (ANCOVA).

Results and Discussions

Research Question 1

What is the attitude of Chemistry students exposed to microscale experimentation approach and those taught with lecture method towards the learning of electrolysis concept in Chemistry? This research question is answered in table 1 below using mean and standard deviation in parenthesis.

Table 1: Mean Scores and Standard Deviation of Chemistry Students' Attitude (Pre and Post) towards Electrolysis Concept in Practical Electrolysis in Chemistry

S/N		EG (N = 75)				CG (N= 37)			
		Attitude				Attitude			
		Pre		Post		Pre		Post	
		Mean (EG)	Level	Mean (EG)	Level	Mean (CG)	Level	Mean (CG)	Level
1	Students' Attitude Regarding the Concepts of Electrolysis	2.78 (0.81)	High	3.43 (0.61)	High	2.78 (0.96)	High	3.10 (0.81)	High
2	Students' Attitude towards the Method of Teaching Electrolysis	2.67 (0.92)	High	3.42 (0.67)	High	2.34 (1.03)	Low	3.11 (0.77)	High
3	Students' Attitude towards the Chemistry Teacher	3.09 (0.87)	High	3.49 (0.61)	High	2.54 (1.09)	High	3.05 (0.86)	High
	Total	2.84 (0.86)	High	3.44 (0.63)	High	2.55 (1.02)	High	3.08 (0.81)	High

EG = Experimental Group; CG = Control Group

Table 1 shows students' attitude toward electrolysis as a concept in Chemistry, students' attitude toward the method of teaching electrolysis and students' attitude towards the Chemistry teacher. This revealed students' attitude before (pre-attitude) and after (post-attitude) the instructional intervention. The criterion mean of 2.50 was used to establish a positive (high) and negative (low) attitude. From the table (Item 1), shows Chemistry students' attitude toward electrolysis when taught the concept of electrolysis using microscale experimentation approach with a pre-attitude mean score of 2.78 and standard deviation 0. 81 while their post-attitude mean and standard deviation 3.43 and 0.61 were obtained respectively. Similarly, students taught with lecture method had 2.78 as their pre-attitude mean score and 0.96 Standard Deviation with a post-attitude mean score of 3.10 and 0.81 Standard Deviation.

The table (Item 2), also indicates that students' attitude toward the method of teaching electrolysis is higher than 2.50, as revealed in the mean score of 2.67 and 0.92 Standard Deviation for students exposed to microscale experimentation approach with the post-attitude mean score of 3.42 and 0.67 as standard deviation. Students taught with lecture method had pre-attitude mean score and standard deviation 2.34 and 1.03 respectively while their post-attitude mean was 3.11 and 0.77, standard deviation. The table (Item 3), revealed that students' pre-attitude mean score was 3.09 and 0.87 standard deviation, while their post-attitude mean score was 3.49 and 0.61standard deviation for students taught the concept of electrolysis using microscale experimentation approach. Students taught with lecture method had pre-attitude mean score of 2.54 and 1.09 standard deviation with a post-attitude mean score of 3.05 and 0.86 Standard Deviation.

Research Question 2

What is the effect of gender and method of teaching on students' post-test attitude towards the learning of the concept of electrolysis? This research question is answered in the tables below using mean and standard deviation in parenthesis.

Table 2: Male and Female Mean and Standard Deviation for Chemistry Students' Attitude (Pre and Post) towards Electrolysis Concept in Practical Electrolysis in Chemistry

S/N		EG (N = 75)				CG (N= 37)			
		Attitude				Attitude			
		Pre		Post		Pre		Post	
		Mean (EG)	Mean (EG)	Mean (EG)	Mean (EG)	Mean (CG)	Mean (CG)	Mean (CG)	Mean (CG)
		M	F	M	F	M	F	M	F
1	Students' Attitude Regarding the Concepts of Electrolysis	2.78 (0.86)	2.77 (0.82)	3.33 (0.64)	3.56 (0.60)	2.66 (1.07)	2.95 (0.88)	3.23 (0.71)	3.06 (0.79)
2	Students' Attitude towards the Method of Teaching Electrolysis	2.66 (0.91)	2.69 (0.90)	3.35 (0.61)	3.52 (0.60)	2.04 (0.93)	2.78 (0.95)	2.97 (0.67)	3.10 (0.87)
3	Students' Attitude towards the Chemistry Teacher	3.29 (0.85)	3.24 (0.84)	3.46 (0.61)	3.53 (0.62)	2.33 (1.00)	2.85 (1.07)	2.92 (0.77)	3.08 (0.98)
	Total	2.91 (0.87)	2.90 (0.85)	3.38 (0.62)	3.53 (0.60)	2.34 (1.00)	2.86 (0.96)	3.04 (0.71)	3.08 (0.88)

EG = Experimental Group; CG = Control Group

Table 2 shows that both male and female students have a positive attitude toward electrolysis concept. The table revealed that the average pre-attitude mean values for both male and female students towards electrolysis as a concept in Chemistry was 2.78 for males and 2.77 for females in the experimental group, while 2.66 for males and 2.95 females was obtained for students in the control group. Similarly, the average post attitude mean value for male and female students in the experimental group were 3.33 and 3.56, while 3.23 and 3.06 were obtained for male and female students in the control group respectively. In all, the mean values are higher than the criterion mean value of 2.50 which implies that male and female students have their attitude positively improved.

Table 2 also shows male and female students' pre and post attitude toward the method of teaching electrolysis. The table revealed the average mean values as 2.66 for males and 2.69for female in the experimental group, while students in the control group had 2.04 for males and 2.78 for females for pre-attitude. The post attitude average mean values of 3.35 for male and 3.52 for female was obtained for the experimental group, while the control group has 2.97for male and 3.10 for female. Similarly, table 2 also shows the male and female students' pre and post attitude toward the Chemistry teachers. This was revealed in the pre-attitude mean values of 3.29 for males and 3.24 for females for students in the experimental group, while 2.33 for male and 2.85 for female for students in the control group. The post attitude mean values for male and female students in the experimental group were 3.46 and 3.53 respectively, while students in the control group had 2.92 for males and 3.08 for females.

Hypothesis 1

There is no significant difference in the attitude (pre-attitude and post-attitude) of Chemistry students in the experimental group and those in the control group. The result obtained using ANCOVA is shown in Table 3.

Table 3: Analysis of Covariance (ANCOVA) of post-attitude; classified by treatment using pre-test as covariates

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2355.283[a]	3	785.094	11.060	.001
Intercept	16810.066	1	16810.066	236.81	.001
Pre- Attitude	329.221	1	329.221	1	.033
Method	1478.506	2	739.253	4.638	.001
Error	7666.396	108	70.985	10.414	
Total	725862.000	112			
Corrected Total	10021.679	111			

R Squared = 235 (Adjusted R Squared =.214)

Table 3 shows that F (2,108) = 4.638, p =.001, the result of the analysis, therefore, indicates that there was a significant difference in the post attitude of students after the instructional intervention. As such, the main effect of the treatment was significant on the attitude of Chemistry students towards the concept of electrolysis. This shows that students exposed to microscale experimentation have their attitude greatly influenced positively than their counterparts taught with lecture method. Hence, the hypothesis of no significant difference in Chemistry students' post attitude was rejected.

Discussion of the Findings

Effects of Microscale Experimentation Approach on Students' Attitude towards Chemistry

Table 1 showed the pre and post attitude of Chemistry students. This indicates that the attitude of students towards electrolysis can be influenced by factors such as their perception of electrolysis as a concept in Chemistry, the method of presentation as well as the Chemistry teacher's ability. This includes the competency of the Chemistry teacher, the mastery ability of the concept, the method and approaches employed in the process of teaching. In other words, the way students perceive the concept of electrolysis would be greatly influenced by the Chemistry teacher and the method of instruction utilized by the Chemistry teacher. Therefore, to ascertain if the influence of students' attitude was significant a statistical analysis tool of ANCOVA was used to test the statistical significance of students' attitude. Table 3 shows that F (2,108) = 4.638, p =. 001, As such, the main effect of the treatment (microscale experimentation) was significant on the attitude of Chemistry students towards the concept of electrolysis. This shows that students exposed to microscale experimentation had their attitude greatly influenced positively than their counterparts taught with lecture method. Hence, the hypothesis of no significant difference on Chemistry students' post attitude was rejected. This is in agreement with the findings of Delmang and Gongden (2016) [7] which affirmed that the instructional method used by the Chemistry teacher could influence or change the attitude of students positively towards Chemistry. Similarly, Savelsbergh, Prins, Rietbergen, Fechner, Vaessen, Drayer and Bakker (2016) [13] found out that the use of innovative teaching approaches has positive effects on students' attitude. Therefore, there is a clear relationship between students' attitude towards Chemistry and their performance. This was proven by the findings of this study which is also in accordance with the findings of Farhana and Zainun (2012) [8] which affirms that Chemistry students have a positive attitude when they are actively involved and allowed to carry out experiments in Chemistry. This indicates that students prefer hands-on-activities to a talk-chalk method of teaching. Similarly, the finding of Aktamis, Hidge and Ozden (2016) [4], shows that students taught with inquiry-based learning when compared to those taught with traditional lecture method had much more positive effects on students' attitude toward science. Yildirim and Berberoglu (2012) [14] also assert that the inquiry-based learning approach has a statistically significant influence on students' attitude towards science. Therefore, it's a fact that when students are motivated to learn, they develop a positive attitude which results in better performance. As such, the attitude of students towards Chemistry is a vital factor in students' academic performance in Chemistry. Hence, attitude and academic achievement are basic outcomes of science education in secondary schools, Najdi (2013) [11].

The implication of this is that when students are taught using the appropriate method of instruction, they are motivated to learn and in turn, they perform better. Hence, a significant relationship exists between students' performance and their attitude towards Chemistry. Therefore, the understanding of the different factors that contribute to students' attitude towards electrolysis as a concept in Chemistry, will help in

identifying the areas to be improved upon so as to create a better Chemistry education. However, the study also revealed the general view of students on certain factors that contribute to a negative attitude towards electrolysis as a concept in Chemistry. One of such factors is that the concept of electrolysis is what they cannot see or touch as teaching is going on. In other words, the electrolysis concept is an abstract concept. Students also affirmed that they dislike the method of teaching used by their Chemistry teachers whereby he/she talks and writes on the chalkboard without any experiment or practical activities. Similarly, students also claimed that the Chemistry teacher is another factor that influences their negative attitude towards Chemistry. According to them, the Chemistry teacher does not make use of instructional materials while teaching the concept of electrolysis neither was any experiment performed. Thus, negative attitude of students towards Chemistry could be due to lack of interest on the part of students as a result of their perception of Chemistry as being abstract, the method of teaching and the Chemistry teacher.

Conclusion

The study, therefore, revealed that microscale experimentation approach is gender friendly as both male and female students benefited from the instructional approach. The findings showed that students exposed to microscale experimentation approach to a high extent had a much more positive attitude when compared to their counterparts in the control group who were taught with lecture method. Therefore, microscale experimentation instructional approach should be embraced by Chemistry teachers in order to effectively develop a positive attitude in students that result in the better academic performance of Chemistry students.

Recommendations

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

1. There should be adequate time allocated for practical experiments and demonstrations for adequate participation of students. This is to enable students to carry out the experiment which in turn helps to develop a positive attitude as they learn by doing what scientist do.
2. Chemistry teachers should exhibit a positive disposition toward Chemistry as a subject.

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