Original Article

Applied Science

Comparative Effect of Using Improvised Freefall Apparatus and Bomb Calorimeter in Teaching the Concept of Enthalpy in Nigeria Senior Secondary School Chemistry

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ABSTRACT [ENGLISH/ANGLAIS]

The purpose of the study was to determine the effectiveness of using improvised freefall apparatus and bomb calorimeter in teaching the concept of enthalpy. This is in response to the call for the deployment of materials within the learners' immediate environment as a means of finding a solution to persistent shortage of learning resources for the teaching of Chemistry in Nigeria Secondary Schools. A total of 93 Senior Secondary two (SS2) chemistry students were involved in the study. This number was made up of 48 females and 45 males from four secondary schools in Calabar Educational Zone of Cross River State of Nigeria. A pretest – posttest control group design was used for the study. Analysis of Covariance (ANCOVA) was used to analyze the data. From the finding it was observed that improvised freefall apparatus as a resource for teaching the concept of enthalpy was more effective in enhancing students' academic performance in chemistry as compared to bomb calorimeter. The result also showed an insignificant difference existing between the performance of male and female students when taught the concept of enthalpy using freefall apparatus.

Keywords: Improvisation, freefall apparatus, bombcalorimeter, enthalpy and academic performance

RÉSUMÉ [FRANÇAIS/FRENCH]

Le but de cette étude était de déterminer l'efficacité de l'aide improvisée appareil de chute libre et bombe calorimétrique dans l'enseignement de la notion d'enthalpie. C'est en réponse à l'appel pour le déploiement du matériel au sein de l'environnement immédiatdes apprenants comme un moyen de trouver une solution à la pénurie persistante de ressources d'apprentissage pour l'enseignement de la chimie dans les écolessecondaires du Nigeria. Un total de 93 Senior Secondary deux étudiants en chimie (SS2)ont été impliqués dans l'étude. Ce nombre était constitué de 48 femelles et 45 mâles de quatre écoles secondaires à Calabar éducation Zone d'Etat de Cross River au Nigeria.Un pré-test - post-test de conception groupe de contrôle a été utilisé pour l'étude.L'analyse de covariance (ANCOVA) a été utilisé pour analyser les données. De la constatation qu'il a été observé que improvisée appareil chute libre comme une ressource pour l'enseignement de la notion d'enthalpie a été plus efficace dans l'amélioration de la performance scolaire des élèves en chimie par rapport à bombe calorimétrique. Le résultat a également montré une différence non significative qui existe entre le rendement des élèves masculins et féminins quand elle est enseignée la notion d'enthalpie en utilisant un appareil de chute libre.

Mots-clés: Improvisation, appareils chute libre, bombcalorimeter, enthalpie et le rendement scolaire

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INTRODUCTION

Enthalpy is a concept in chemistry; it is all about heat changes whether exothermic or endothermic heat release. The effective teaching of this concept can be approached in two different ways, teaching with standard laboratory materials and also with improvised materials.

Using standard laboratory materials to teach science will enable the learner to develop problem solving skills and positive attitude, acquire scientific application and interests as well as developing functional knowledge and manipulative skills, [1]. But using improvised materials in teaching science concepts will enable the learners to

acquire more of what is obtained with standard materials. Bormide [2]. suggested that the mastery of chemistry concept (enthalpy) cannot be fully achieved without the use of learning instructional materials in teaching.Studentshave to be taught the concept (enthalpy) with improvised learning materials so as to enable them acquire the cognitive competence and process skills that they need for learning the concept.

Improvisation is described as the act of using standard materials or local materials from the environment or teachers made materials to enhance instruction [2, 3] Balogun [3] said that in developing learning and teaching materials, the use of learners' environment and locally available resources should be used in providing first hand science experience. It is believed that if locally improvised materials are effectively used, it will motivate the learners depending on how the learners perceive and pays attention to this local improvised materials used.

The use of local materials in science teaching implies the utilization of the scientist's environment, which is a practice in improvisation [4]. He advocates the use of local materials in chemistry education. He admitted that we are yet to devise school – based experiments to illustrate, justify or explain the usage of such materials. Studies by Ezeliora [5] showed that locally improvised materials showed superior effect on students achievement and interest, the more familiar the students are with the instructional environment of a science class, the more interest they are likely to develop and hence more achievement in the concept.

It is pertinent to emphasise that there is urgent need for chemistry educators to re-examine the present method of teaching chemistry with a view to adopting an approach that involves largely experimental methods in which effective utilization of available local material could be used. Though some works have started, it is not yet exhausted since (57.1%) of senior secondary chemistry topics can be taught using improvised materials,[6] since science is better learned through the process approach it is important for science teachers to look for learning and teaching resources beyond the classroom.

Freefall apparatus is designed from scrap of metals which are readily available in our local environment. Examples are iron rods, pipes and discarded metal springs (see Appendix 1). On this ground the need to use locally improvised freefall apparatus in teaching the concept of enthalpy is in support of Eshiet [7] that the environment provides a situation that helps learners to acquire experience that enhance learning in the affective, psychomotor and cognitive domain.

A study by Bernedetta [8] showed that students in Nigeria secondary schools have difficulties in learning certain chemistry concepts, such as solubility, redox reactions, electrolysis and enthalpy. Chemistry as a science is activity oriented and the suggested method for teaching it, which is guided-discovery method is resource based [7]. There is inadequate utilization of learning resources within the learner's environment by science teachers , [4].

This suggests that the mastery of chemistry concepts cannot be fully achieved without the use of learning materials in teaching chemistry. So the teaching of chemistry without learning materials will certainly result to poor achievement and lack of interest on the course. There is deficiency in the development of chemistry in Nigeria senior secondary schools, and could be traced to unavailability of effective teaching and learning resources in our science classrooms [9]. Also teachers have not been able to utilize resources within our environment to enhance teaching and learning of science (chemistry).

This work sought therefore, to provide an example of deploying local materials like improvised freefall apparatus in teaching the concept of enthalpy rather than using conventional bomb calorimeter.

The purpose of the study was to achieve the following: To compare the effects of using improvised freefall apparatus and standard bomb calorimeter in teaching the concept of enthalpy on student's academic performance in chemistry and also to determine the influence of gender on students' performance when taught the concept of enthalpy using freefall apparatus.

The following hypotheses were formulated to guide the study. There is no significant difference in the performance of students when taught the concept of enthalpy using improvised freefall apparatus compared to using standard bomb calorimeter. Secondly, there is no significant difference between the performance of male and female students when taught the concept of enthalpy using freefall apparatus

MATERIALS AND METHODS

A pretest-posttest control group design was used in the study. On sample and sampling technique, a total of ninety three (93) students took part in the study using intact classes, out of a population of two hundred and ten (210) chemistry students in Calabar Educational Zone of Cross River State. This was made up of 45 male students

and 48 female students. Purposive sampling technique was used to select schools from the population. The criteria were:

(1) Schools that have graduate teachers in Chemistry with at least three years of teaching experience.
(2) Schools with well-equip Chemistry Laboratory.
(3) Schools in which the concept of enthalpy have not been taught.

Eight schools met the criteria, out of which four schools were randomly selected through the use of balloting. They were randomly assigned to experimental and control groups. There were two experimental groups made up of 26 and 24 students respectively and also two control groups made up of 20 and 23 students respectively.

A researcher design Chemistry Achievement Test (CAT) was used for the study. A total of (30) multiple – choice items were constructed on the concept of enthalpy. The instrument was faced and content validated by Chemistry experts in the Department of Science Education, University of Uyo. Reliability of instrument was determined using Kuder-Richardson formula 21. A reliability index of 0.89 was obtained.

The following research procedure was used. Prior to the actual execution of the study, the students in the experimental groups were asked to have a close study of the freefall apparatus by research assistants, while the control groups were supplied with bomb calorimeters. Pretest was administered to the two groups (experimental and control groups) for one hour. Treatment was given to the experimental groups for three weeks. The experimental groups were taught the concept of enthalpy using freefall apparatus while the control groups were taught the same concept for the same period of time, without freefall apparatus.

After which posttest was administered to the two groups (experimental and control) for one hour.

The data collected were analyzed by using Analysis of Covariance (ANCOVA) using pretest as covariates. All hypotheses were tested at 0.05 level of significance.

RESULTS

Table 1 shows that the materials mean effect was significant at P<.05. The calculated F- value 13.05 was greater than the critical F-value 3.94,therefore the null hypothesis which stated that there was no significant difference in the performance of the students when taught the concept of enthalpy using improvised freefall apparatus compared to using bomb calorimeter was rejected. However, consequent upon the existence of significant different in the performance of chemistry students taught with freefall apparatus and those taught with bomb calorimeter, Multiple Classification Analysis (MCA) was considered to determine the specific contribution of the levels of instructional materials to gain in students performance in chemistry

Table 2 shows that students taught with freefall apparatus performed significantly better than those taught with bomb calorimeter. The table also indicates a multiple regression index of R = 0.703 with a multiple regression squared of R^2 = 0.495. This implies that 49.5% of the total variance in the performance of students in chemistry is attributed to the influence of equipment used for teaching the concept of Enthalpy

Table 3 shows that the gender main effect was not significant at P<0.05. The calculated F-value 0.93 was less than the critical F-value, 4.04, therefore the null hypothesis which stated that there is no significant difference between the performance of male and female students when taught the concept of Enthalpy using freefall apparatus was retained.

Table 1: This table shows analysis of Covariance (ANCOVA) of the performance of students taught with freefall apparatus and those taught with Bomb Calorimeter using pretest scores as covariates

Sources of Variation	SS	DF	MS	F-Cal	F-Crit	Decision P<at.05
Pretest	404.83	1	404.8	14.10	3.94	*
Corrected Model	1028.17	2	514.09	17.91		*
Intercept	1293.94	1	1293.9	45.08		*
Equipment	374.52	1	4	13.05		*
Error	2583.53	90	374.52			
Total	136388.0	93	28.71			
Corrected	0	92				
Total	3611.70					

** = Significance at <.05 alpha level, critical; F. –Value at P<.05 alpha level = 3.94*

Table 2: This table shows Multiple Classification Analysis (MCA) of post-test scores of students taught with improvised materials and those taught with standard materials

Grand Mean = 37.78	N	Unadjusted		Adjusted for Independent variable % covariates	
Variable + Category		Dev'n	Eta 0.59	Dev'n	Beta 0.49
Equipment	48	2.51		2.00	
Standard	45	-2.67		-2.14	
Improvised					

Multiple R = 0.703; Multiple R^2 = 0.495

Table 3: This table shows Analysis of Covariance (ANCOVA) of post-test score of male and female chemistry students taught using freefall apparatus

Source of Variation	SS	Df	Ms	F-cal	F-crit	Decision at P<.05
Pretest	178.42	1	178.4	5.14	4.04	*
Correction mode	236.72	2	2	2.27		NS
Intercept	648.91	1	118.3	18.69		*
Equipment	32.25	1	6	0.93		NS
Error	1423.73	44	648.9			NS
Total	57136.0	48	1			
Corrected	0	47	32.25			
Total	1660.44		32.36			

** = Significant at P<0.05 alpha level; NS = Not Significant at P>0.05; Critical F-value = 4.04*

DISCUSSION

The results of hypothesis one showed that a significant difference was found to exist between the performances of students taught the concept of enthalpy using freefall apparatus and those taught using bomb calorimeter. The findings as shown in table 1 indicated that students taught the concept of enthalpy using freefall apparatus performed significantly better than those taught with bomb calorimeter. The result also showed that 49.5% of the total variance in the performance of students in chemistry was attributed to the influence of equipment used for teaching, the concept of Enthalpy.

This might be due to the fact that improvisation encourages innovative thinking, creativity and resourcefulness. Also using local materials from the environment for teaching, enhance students interest and attitudes towards the subject due to the nature and level of activities in the class. This is in line with the finding, of Ezeliora [5] that locally improvised materials showed superior effect on students' achievement and interest in chemistry more than standard material. This was consistent with the findings that resource materials from the environment were effective in enhancing achievement and interest in science [10, 11].

The result of hypothesis two showed that there was no significant difference in the performance of male and female students when taught the concept of enthalpy using freefall apparatus. This study is in line with the findings of Leinhart [12] that shows no significant difference in the mean performance between boys and girls in the manipulation of the same instructional materials. Also Onwioduokit [12] investigated the effect of gender differences among undergraduate student enrollment and academic performance in science and concluded that women's performance in science is not significantly different from that of men.

Locally improvised models and resources engender interest and increase achievement in the student than the standard models and materials. The more familiar the students are with the instructional environment of a science class, the more interest they are likely to develop and hence more achievement in the subject [14].

CONCLUSION

On the basis of the findings in this study, the following conclusions were drawn: There exists significant difference between the performance of students taught with improvised freefall apparatus and those taught with bomb calorimeter. And also there exists no significant difference between the performance of male and female chemistry students when taught the concept of enthalpy using freefall apparatus.

RECOMMENDATIONS

It is therefore recommended that science teachers (Chemistry) should make use of tea teaching resources

within the learners' environment in teaching chemistry concepts.

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CONFLICT OF INTEREST

No conflict of interests was declared by authors.