Scholarly Journal of Education Vol. 8(1), pp. 17-21, April, 2021
Available online at http:// www.scholarly-journals.com/SJE
ISSN 2315-6155 © 2021 Scholarly-Journals

Full Length Research Paper

The Effect of Ball and Stick Model on Students' Academic Achievement in Chemistry in Obio/Akpor Local Government Area in Rivers State, Nigeria

Abbey-Kalio, Ibiyengibo

Ignatius Ajuru University of education, Port Harcourt, rivers state, Nigeria. Department of chemistry.
Email: ibkalio@yahoo.com

Received: 5 April, 2021, Accepted: 20 April, 2021, Published: 30 April, 2021

The study investigated the effectiveness of ball and stick model in the teaching of Chemistry in Senior Secondary Schools in Obio/Akpor local government area in Rivers State. A sample size of 115 (experimental group 64 and control group 51) out of a population of 3025 was used for the study. The quasi – experimental design specifically, pretest post posttest non-randomized with students in intact classes was used. Two research questions were answered while two hypotheses were tested at 0.05 level of significance in the study. The instrument for data collection was Chemistry achievement test (CAT) on organic Chemistry aspect of Senior Secondary School syllabus. The research questions were answered using means and standard deviations while the hypotheses were tested using ANCOVA. It was found out that the use of ball and stick models instructional materials in teaching of Chemistry significantly enhanced the academic achievement of students in Chemistry but there was no significant difference found in the achievement based on gender. Hence, it was recommended among others that Chemistry teachers should be creative and innovative in the providing and utilization of instructional materials for the teaching and learning of Chemistry.

Keywords: Ball-and-stick, organic Chemistry, Carbon, structure, instructional materials, models

INTRODUCTION

Chemistry as a science subject teaches about more than a hundred elements existing in various living and non-living things. Amongst these, carbon element is prevalence. The element carbon is unique in nature in that it has the ability to link with itself to form chains by the process known as catenation and also can link with other elements such as hydrogen, oxygen, nitrogen, phosphorus, sulphur and by this means form so many substances some very complex and gigantic e.g. polymers (https://www.toppr.com.>chemistry).There are three modes of bonding displays by carbon namely:

1. Single bond with bond angle of 109.5^{o}
2. Double bond with bond angle of 120^{o}
3. Triple bond with bond angle of 180^{o}

Due to the fact that carbon has the ability to form larger and complex compounds, it is exclusively designated a branch of Chemistry known as organic Chemistry which is the study of carbon compounds (https://www.sciencedirect.com>topics).

Historically, organic Chemistry originated from the study of living organism (plants and animals) or once living materials (coal, oil) and were thought to contain a ''vital force'' based on their origin (https://chem.libretexts.org/@ago/page/24379). Since 1957, International Materials Registry have listed more than 13 million (70%) of organic compounds from living organism and others synthesized (https://doi.org/10.1016/j.gsf.2017.07.007). Today chemists have developed and manufactured medicine drugs e.g. antibiotics; in agricultural industry – manufacture of insecticides, pesticides, fungicides etc. food such as sugar, peanut oil are of organic origin; the most important modern fuel – petroleum and natural gas, polymers – plastic, nylon, polyethene, clothing we wear and our household items a lot of which are organic. In some of these compounds, carbon aside combing with

itself also combines with few other elements accordingly: C – C; C – H; C – O; C – N; C – S and C –X (F, Cl, Br & I) (https://www.britannia.com>science)

For easier studying of organic Chemistry, the study has been divided into few other classes according to their functions/properties. A functional group is a group of atoms that is largely responsible for the characteristic behavior of the parent molecule. Classes of such compounds that form the backbone of organic Chemistry are the hydrocarbons. Hydrocarbons are organic compounds that are made up of only carbon and hydrogen elements (https://www.britaania.com>science).

For more simplicity in the study of chemical reactions and compounds, symbols, chemical formula and chemical equations are used in the learning of Chemistry more specific to organic Chemistry, structures are equally useful. Most of the organic substances – e.g. Polymers (plastics, nylons and polyethene) are built up from simple organic units. Such building units can be linked to form gigantic organic compounds. Hence, is it imperative for the learner in Chemistry to acquaint himself with the study of how these compounds can be build up from the discrete units and how these individual structure are usually denoted with symbols. In this wise, instructional materials of various types can be used to illustrate how organic structures are arranged in the molecules. More so, effective and efficient teaching and learning cannot be fully achieved without application of instructional materials for proper demonstration of especially learning of concepts in Chemistry that has to do with atoms which are very tiny particles that are not visible to human viewing and in other cases very complex structure of chemical compounds.

Studies have proven that when instructional materials are utilized in the teaching and learning process, students are bound to assimilate and retain knowledge and skills learnt. This means that instructional materials are means to improve students' academic achievement (Behar – Horenstein & Seabert, 2005). Therefore, what both Chemistry teachers and learners stand to benefit from the use of instructional materials in teaching – learning process in Chemistry cannot be completely done with, in a short piece of writing. According to Bawa (2016), the importance of instructional materials in the development of learners' intellectual abilities and attainment of teaching and learning objectives cannot be over-emphasized

Instructional materials are devices or objects employ by teachers to facilitate the teaching and learning process (Abubakar, 2020). According to Adalikwu and Lorkpilgh, (2013) Instructional materials are format and strategies that serve for guidance function in aiding a learner to achieve specific learning outcomes as stated in behavioral forms. So instructional materials are not just objects but as well serve as methods that are applied by the teacher to help the learner to learner faster and better. These materials can also come in several different forms, so it is expected that the teacher sort for variety of materials to bring learning home to the learner in which instance, the teacher has to be creative and innovative. Instructional materials can be in form of chart, technological equipment, model etc.

According to Njoku (2004), models are ideas or imaginations that attempt to give reason why aspects of the physical, natural or man-made (the way things in the) world stays the same or behave the way they do. Models represent the real objects or situations, an expression of the true nature of an object or the feature related to what builds up the systems. Models improve reasoning capacity and learning abilities therefore form very essential instructional materials in the teaching of structures in organic Chemistry and generally in learning in Chemistry where abstract concepts are difficult for students to assimilate.

In 1865, a chemist Wilhelm August Hofmann first used colored ball to represent the elements while John Dalton in the 19th century used ball and stick to describe the structure of the atoms (cited in Babilonia, Kouns & Oliver-Hiyo, 2018). Currently, there are various different models which can be used to illustrate the several different properties of chemical substances ranging from shapes, flexibility and relative size of chemical compounds. There are mental models for verbal or diagrammatic representations such models are the ball-and-stick models, skeletal models. Polyhedral models, composite models, crystal lattice models and computer-based models are popular amongst them. Others are scale models, analogue models and mathematical models (Njoku, 2004).

The ball-and-stick models are three dimensional (3D) models used in illustrating relative bond lengths and bond angles. The choice of this model is to show molecular geometry of most structures with great level of ease. The ball-and-stick models consist of colored balls which are spherical and represent specific atoms while the sticks which are rods connect the atoms and equally represent the chemical bonds. In any chemical compound, 2 or 3 curved rods are used to represent double and triple bonds respectively (https://psiberg.com>ball-and-stick).

Statement of the problem

Several factors are responsible for students' poor-academic achievement in Chemistry; this includes non-availability and not usability of appropriate instructional materials in the teaching and learning process. While it is a fact that most concepts in Chemistry are based on particular nature of matter (atoms) which are not visible to human viewing and so difficult for learners' easy comprehension, it is said to note that most Chemistry teachers in government Senior Secondary School in Obio/Akpor local government area of Rivers State are in the habit of dodging the use of instructional materials.

This is the reason learners' intellectual abilities are hardly developed and the teaching and learning objective are equally not always attained because students find it difficult to understand these concept due to their abstractness.

Research questions

1. What is the mean achievement scores of students taught Chemistry using ball-and-stick models instructional materials and those taught without the models?
2. What is the mean achievement scores of students taught Chemistry using ball-and-stick models instructional materials and those taught without the models based on gender?

Hypotheses

1. Ho1: There is no significant difference between the mean achievement scores of students taught
2. Chemistry using ball-and-stick model instructional materials and those taught without the models.
3. Ho2: There is no significant difference between the mean achievement scores of students taught Chemistry using ball-and-stick model instructional materials and those without the models based on gender.

PRESENTATION OF RESULTS

Research questions 1

1. What is the mean achievement scores of students taught Chemistry using ball-and-stick models instructional materials and those taught without the models?

Table 1 means and standard deviations of achievement scores of students taught Chemistry using ball-and-stick models instructional materials and those taught without the models.

Group	No. of Cases	Pre-test		Post-test		Mean gain
		Mean	SD	Mean	SD	
Experimental group	64	5.41	2.512	15.16	3.349	9.75
Control group	51	5.18	2.304	11.18	3.559	6.66
Total	115					

Table 2 means and standard deviations of achievement scores of students taught Chemistry using ball-and-stick models instructional materials and those taught without the models based on gender?

Group	No. of Cases	Pre-test		Post-test		Mean gain
		Mean	SD	Mean	SD	
Male	38	5.47	2.778	14.95	3.296	9.88
Female	26	5.31	2.112	15.46	3.249	10.15
Total	64					

Experimental group has a mean score of 9.75 while control group has mean score of 6.66 meaning that experimental group which used ball-and-stick models instructional materials performed better than their counterpart.

Research question 2

What is the mean achievement scores of students taught Chemistry using ball-and-stick models instructional materials and those taught without the models based on gender?

Mean achievement gain of female 10.15 is slightly higher than mean achievement gain of male 9.88, showing that female performance is better than their male counterpart that were taught Chemistry without the ball-and-stick model instructional materials.

Hypothesis 1

Ho1: There is no significant difference between the mean achievement scores of students taught Chemistry using ball-and-stick model instructional materials and those taught without the models.

Therefore the null hypothesis that there is no significance difference in mean achievement scores of

Table 3 ANCOVA analyses of students taught Chemistry using ball-and-stick models instructional materials and those taught Chemistry without using the model.

Source of Variations	Sum of squares	df	Mean square	F	Significance
Corrected model	571.577	4	142.894	14.565	.000
Intercept	205.160	1	205.160	209.486	.000
Pre-test	255.346	1	255.346	26.028	.000
Groups	288.229	1	288.229	29.380	.000
Error	1079.154	110	9.810		
Total	23194.000	115			
Corrected total	1650.730	114			

P(0.00)<0.05 level of significance

Table 4 ANCOVA analyses of students taught Chemistry using ball-and-stick models instructional materials and those taught Chemistry without using the model based on gender.

Source of Variations	Sum of squares	df	Mean squares	F	Significance
Corrected model	77.954	2	38.977	3.783	.028
Intercept	1855.601	1	855.601	180.103	.000
Pre-test	73.873	1	73.873	7.170	.010
Gender	5.291	1	5.291	.514	.476
Error	628.484	61	10.303		
Total	15408.000	64			
Corrected total	706.438	63			

students taught Chemistry using ball-and-stick model instructional materials and those taught without the models is rejected, meaning that there is significant difference.

Hypothesis 2

Ho2: There is no significant difference between the mean achievement scores of students taught Chemistry using ball-and-stick model instructional materials and those without the models based on gender.

P(.476)<0.05 is not significant at 0.05 level of significance. There is no significant difference between the mean achievement scores of students taught Chemistry using ball-and-stick model instructional materials and those without the models based on gender. Therefore the null hypothesis is retained.

DISCUSSION

The findings on table 1 showed that the students taught Chemistry using ball-and-stick models instructional materials performed better than those taught Chemistry without the models. This further reveals significant difference between the two groups. Hence, use of ball-and-stick models as instructional materials in the teaching and learning particularly of Chemistry as a subject is a way to enhance students' academic achievement. The findings are in agreement with the findings of Okonkwo, (2016); Ehonuean, (2015) and Abdu-Raheed, (2011) who in their separate studies found improvement in students learning with the use of instructional materials.

The study also revealed no significant difference between male and female in their academic achievement after being taught using ball-and-stick model instructional materials, though the mean scores was slightly higher for the females. This no disparity in gender in the understanding of science is in support with the study of Ajayi and Ogheba (2017) who found no significant difference between male and female students on gender differences in stoichiometry using hands-on activities.

Conclusively, teaching of Chemistry with the use of ball-and-stick models instructional materials is the right way to enhance students' academic achievement and both male and female students have same ability in the use of these instructional materials.

RECOMMENDATIONS

Based on the findings of the study, it is recommended that:

1. The government through the Ministry of Education should provide Funds for Schools to purchase adequate instructional materials for teaching and learning process.
2. Chemistry teachers on their part should be creative and innovative in their approach by providing and the use of variety of instructional materials especially from students' immediate environment to illustrate abstract

3. and difficult concepts.
4. Chemistry teachers and students should engage in seminars, conferences and workshop to improve in the creating and utilization of various instructional materials for teaching and learning respectively.
5. Principals of schools should engage in regular supervision to ensure the use of adequate instructional materials by teachers during teaching and learning.

REFERENCES

Adalikwu, S. & Lorkpilgh, I. (2013). The influence of instructional materials on academic performance of senior secondary school students in Chemistry in Cross River State, Global J. Edu. Res. 2(1) 39 – 49.

Abubakar, M.B. (2020). Impact of instructional materials on students' academic performance in Physics in Sokoto, Nigeria. *Journal of the 2nd International Conference of Civil and Environmental Engineering, 476*(1).

Ajayi, O. V. & Ogbeba, J. (2017). Impact of gender on Senior Secondary Students academic achievement in stoichiometry using hands-on activies. *American J. Edu. Res. 5(*8) 839 – 842.

Babilonia, R.M.A; Kouns, H.K & Oliver-Hoyo, M.T. (2018). Using 3D printed Physics models to monitor knowledge integration in Biochemistry. J. Chemi. Edu. Res. and Practice, 19(4), 1199 – 1215.

Bawa, N. (2016). Effect of instructional materials (Computer) in promoting secondary school students' academic performance in Computer Science in Kebbi State. J. Advance Res. in Soc. Stud. and Humanities, 2(7) 1 – 12.

Behar – Horenstein, L. S & Seabert, V. M. (2005). Teachers' use of models for teaching. Educational Sciences: Theory and Practice, 27(1), 49 – 66. Doi:10.7459/epf/27.1.04

Abdu – Raheed, B.O. (2011). Availability, adequacy and utilization of sound instructional amterials in Ekiti State secondary schools. J. Current Discovery and Res. 3(1) 242 -255.

Enohuean, V. O. (2015). Effect of instructional media on teaching Biology in secondary schools in Delta State, Nigeria. J. Edu. 7(1) 117 – 120.

Okonkwo, P. (2016).Impact of instructional materials in teaching and learning of Physics in senior secondary schools in Onitsha. J. MOGF Res. in Edu. 15(1) 1 – 9.

Njoku, Z. C. (2004). Effective use of models for Science and Technology instruction. J.of the Sci. Teachers Association of Nigeria (STAN), 39(1 & 2) 44 – 51.

Https://www.toppr.com>chemistry.

https://www.sciencedirect.com>topics

https://chem.libretexts.org/@ago/page/24379.

https://doi.org/10.1016/j.gsf.2017.07.007.

https://www.britannia.com>science.

https://psiberg.com>ball-and-stick.