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The Effectiveness of An Activity–Based Education Technique Using a Role-Playing Analogy in Improving Students' Conceptual Grasp of Hydrocarbon

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Abstract: *This study determined the effects of activity-based education techniques using the role-play analogy in improving students' conceptual grasp of hydrocarbon. The study adopted a pre-test post-test non-equivalent design, and a quasi-experimental design. [1]Three research questions were raised. The population of this study is 365 students from 15 public secondary schools in Okitipupa Local Government Area of Ondo State The sample for this study consisted of seventy-five S.S.S II chemistry students (35 males and 40 females) with 38 students in the experimental group (18 males and 20 females) and 37 students in control groups (17 males and 20 females) in two senior secondary schools sampled from 15 public mixed schools. This study employed a simple random sampling technique using the balloting method. The instrument used for data collection was the Hydrocarbon Conceptual Cognition Test (HCCT) which was validated through content validity using a table of specification and a reliability coefficient of 0.80 was established. Data collected were analysed using descriptive statistics and analysis of covariance. The findings of this study revealed that students in the experimental group had the highest conception scores compared to students in the control group. The findings also revealed that both education techniques were not gender sensitive and the role-play analogy education technique has positively influenced the hydrocarbon conceptual understanding of students in chemistry. It was therefore recommended that the curriculum developers should review their curriculum and include the use of role-play methods for effective teaching process.*

Keywords: Hydrocarbon, Activity-based education technique, Role- play analogy, students' conceptual grasp,

Introduction

Chemistry is a branch of physical science that focuses on understanding matter's composition, structure, properties and changes. It has to do with the study of matter and the changes that it undergoes. Chemistry deals with the properties and structure of different substances, as well as the way they interact with each other. It is an important field of study because it helps to understand the world around us and allows us to create new materials and products. Different branches of chemistry cover different aspects of the field. The first is physical chemistry which deals with laws and theories that govern how matter behaves, then inorganic chemistry which focuses on

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the properties and behaviour of elements and compounds that contain carbon, next is organic chemistry which looks at the properties and behaviour of carbon-containing compounds and lastly biochemistry which examines the chemistry of living organisms. Chemistry concepts by nature are based on the structure of matters which often makes it refer to "central science "because it bridges other sciences. The concepts in chemistry are divided into three representations which are macroscopic, microscopic and symbolic. Observable phenomena are notions at the macroscopic level. At this point, the ideas are tangible and consist of observable chemicals and solids. The nature, grouping and movement of molecules based on specified qualities are considered to be under microscopic level. This level consists of particulate matter which is used to describe the motion of atoms, molecules, and compounds such as chemical formulas, symbols and structures. This level includes a wide range of graphical representations as well as algebraic and computational sub-microscopic representation types (Wu, Krajcik & Soloway 2000). The ease of comprehension of additional concepts and theories depends on one's ability to grasp these abstract concepts at different levels.

The fact that there is an ongoing interaction between the three levels of concept representation that now exist is one of the chemistry features. Chemistry learning benefits greatly from these interactions and distinctions. This demonstrates that chemical information is taught at three levels. If students experience difficulties in one aspect, it could affect their performance in the other aspect. Research has shown that students have problems forming links across these levels and find both the microscopic and symbolic levels difficult to understand (Griffiths & Preston, 1992) cited in Okoli 2012 and this has affected their performances in examinations.

Despite the prime position chemistry occupies in Nigeria, students still perform poorly in chemistry. According to Eravwoke and Omoifo (2020) West African Examination Council Chief Examiner's reports on students' performance in chemistry, students with credit level and above from 2000 to 2010 have the following percentage in each year respectively: 31.88% (2000), 36.25% (2001), 34.42% (2002), 49.9% (2003), 37.86% (2004), 50.94% (2005), 44.90% (2006), 45.96% (2007), 33.94% (2008), 28.59% (2009) and 49.65% (2010). The trend indicates generally poor performances of students in chemistry, which could be traceable to the difficulty students encounter in understanding both the microscopic and symbolic levels of concept representation into which hydrocarbons fall.

Hydrocarbons are defined as an organic chemical compound that is composed exclusively of hydrogen and carbon atoms. The carbon atoms join together to form a framework of the compound and the hydrogen atoms attached to them in many different configurations. They are the principal constituents of petroleum and natural gas. Hydrocarbon is a difficult concept to understand. Based on the observations of the West Africa Examination Council (WAEC) Chief Examiner report in 2012, this difficulty of hydrocarbon is evidence that led to poor performance of students in chemistry. This observation includes the inability of students to represent molecular formulas structurally, and the student's omission of linking bonds between and among atoms in their structural formula. While the nature of chemistry can be a challenge to students' other factors can contribute to failure in the subject and one of the factors that is of importance to the researcher is the teaching methodologies.

Observations and experience have shown that most of the teachers, teach chemistry concepts irrespective of their levels of representation using lecture methods. The lecture method is a traditional teaching approach where the teacher impacts knowledge to the students giving room for interactions and collaboration of critical thinking skills. Anyaegbunam (2012) opined that many science teachers prefer the lecture method of teaching and shy away from innovation. When the lecture method is applied in the classroom students' level of involvement is very low and this does not promote meaningful learning since the students are not allowed to actively participate in

the learning process than to receive information. Meanwhile, much can be acquired by this method but chemistry by its nature involves highly conceptual understanding.

Conceptual understanding can be defined as the ability to make sense of and explain ideas logically and coherently. It involves a strong foundation of knowledge, critical thinking and making corrections between ideas. Johnson, 2005 cited in Anyaegbunam 2012 defines conceptual understanding as a connected web and network of knowledge in which the linking relationships are as important as the isolated bits of information. It is having an adequate knowledge of the concept learnt and being able to apply the knowledge to other similar situations (Eravwoke, 2016). Conceptual understanding allows a student to apply and possibly adapt some acquired ideas to new situations with ease (Jonassen, 2006). For better student performance through conceptual understanding, teachers should take into consideration the teaching methodologies used in the teaching of chemistry concepts and improve on these methods.

However, one of the teaching methods that has not been widely used in Nigeria that is used in this study is teaching with role play analogy. This role-play analogy comprises two teaching activities namely; role-play and analogy. Role play is an activity that involves students displaying specific roles by his/her understanding of the features of that particular phenomenon under study. According to Yadikar 2004 cited in Agboro Eravwoke and Omoifo (2020) Role play involves physical and intellectual activities that have the potential of clarifying scientific concepts. It can be used to illustrate ideas and promote discussion; therefore, role play serves as a way of encouraging students to think scientifically through analogical reasoning. Naturally, play activity is used to develop one's knowledge and intelligence while the analogy is a comparison of something familiar and unfamiliar. An analogy can be described as a bridge that spans the gap between what the teachers want the students to learn and the student's previous knowledge. Analogy refers to those aspects of the teacher's explanatory discourse in which a familiar concept to be explained is used (Okigbo, 2010). The unfamiliar concept is referred to as target and the familiar is referred to as source. Olorunkooba et al. (2013) define analogy as a process of identifying similarities between the familiar concept (base) and the unfamiliar concept (target). Role play analogy involves active participation of students in the teaching and learning process to enhance the mental activities of students through the process of displaying a specific role based on their understanding using familiar concepts to teach the unfamiliar concept. Through role play analogy in the classroom will help students make connections between what they encounter each day of their lives and the concepts being taught. Therefore, making some chemistry concepts which are unfamiliar and not visible, familiar and visible since what is being taught is based on the similarities and differences between the known concept (source) and the unfamiliar concept (target).

Although empirical studies have demonstrated the value of using role-playing analogies to support chemistry learning, there is a lack of understanding about how students use this analogy to develop conceptual understanding over time. Most existing research reports on the effects of analogy in understanding of science concepts appear more in Physics and Biology, few studies have been done in chemistry. One such study is the study by Shan (2010) which dealt with the effect of analogy on students' understanding of chemical equilibrium, while Sahin and Onwukwe's (2010) study was based on examining the combined effect of play stimulation and teaching while analogy on student's achievement in chemistry. Both studies show a significant positive link between teaching with analogy and students' achievements in chemistry. While the findings of this study provide valuable insights into the use of role-playing analogies in chemistry education, further research is needed to explore the effectiveness of other concepts and teaching strategies in facilitating conceptual understanding. This study sought

to address this gap by investigating how a role-playing analogy intervention could impact the conceptual understanding to improve the performance of low- performing chemistry students.

Statements of the problem

Chemistry serves as an important component in the school curriculum. Despite the uniqueness of chemistry, the West African Examination Council (WAEC) Chief examiner's report has consistently shown a decline in the performance of secondary school chemistry students pointed out the following as some of the reasons for candidates' poor performance in Chemistry as the inability of students to represent molecular formula structurally and inability to name organic compounds correctly: Eravwoke and Omoifo (2020) reported some reasons for candidates' poor performance in chemistry such as students' inability to tackle most numerical questions; expressions and the use of non-chemical terms is poor, poor knowledge of international Union of Pure and Applied Chemistry (IUPAC) naming of organic compounds and inability to write formulae and correct balanced chemical equations.

All these shortcomings are held accountable for teachers' persistent use of the lecture method which had been found ineffective in teaching science. To eradicate this problem, (Omoifo, 2012) recommended that chemistry teachers should improve their teaching methods and this calls for the need to use innovative methods such as activity-based instructional strategies which Role – play is one of them. This study therefore wants to examine the effect the use of the role-play analogy method has on students' conceptual understanding of hydrocarbons.

Research Questions

1. What is the percentage of students in each group who had a correct conception of hydrocarbon before and after instruction?
2. What is the difference in the use of role-playing analogy as a teaching technique that affects students' conception scores in hydrocarbon compared to students who did not use this technique?
3. What is the interaction effect of treatment and sex on conception?

Research Hypotheses

Research question one was answered while two and three were hypothesized at 0.05 level of significance.

1. There is no significant difference in the conception scores on hydrocarbon between the students taught with role-playing analogy (experimental) and the control group.
2. There is no significant interaction effect of treatment and sex on students' conception scores in hydrocarbon.

Methods and Materials

The pre-test post-test non-equivalent control group which was one of the quasi-experimental designs was used in this study. In this design randomization of subjects was not involved. The pre-test score represented the pre-conception score of the students before treatment and the post-test score represented the post-conception score. The population of this study is 365 students from 15 public secondary schools in Okitipupa Local Government Area of Ondo State. The sample size for the study comprised seventy-five (75) S.S.S 2 chemistry students (35 males and 40 females) with 38 students in the experimental group (18 males and 20 females) and 37 students in the control group (17 males and 20 females). Simple random sampling was used to select 2 mixed public schools from 15 schools through balloting. The chemistry teachers for the sampled classes taught the classes. One class is experimental and the other control. The following instruments were used Hydrocarbon Conceptual Congition Test (HCCT) and Model lesson note and plan for the use of activity-based instructional strategy using role play analogy and lecture method.

The Hydrocarbon Conceptual Cognition Test is made up of two sections (A & B). Section A consisted of student's bio-data and section B consisted of 20 items drawn from organic chemistry the items were selected from West Africa Examination Council (WAEC) and National Examination Council (NECO) past questions 2010 – 2022 while the model lesson note plan was also designed for both the experimental group and control group teachers respectively by the researcher. The instruments also contain two sections, section A contains the periods, topic, duration, objectives, instructional aids and procedure to be followed in the experimental and control group and Section B contain the framework on the use of role-play instructional method in the classroom. It is based on the content to be taught, the objectives of the teachers and students' activities, the teaching and learning aid to be used and the evaluation guide to use to determine whether the aims are achieved.

The teachers used for the experimental group underwent training on how to apply role play analogy for teaching. The experimental teacher was instructed to use the role-play analogy for teaching while the teacher for the control group used the lecture method. This study lasted for four weeks. Data was collected in each day spent at each school before the Hydrocarbon Conceptual Condition Test (HCCT) instruments were administered. The instrument was validated through content validity using a table of specifications which showed that the content areas were captured.

Table of specification

content	Knowledge 15%	Comprehension 25%	Application 25%	Analysis 35%	Total No of items
Hydrocarbons 50%	1	3	3	3	10
Aliphatic hydrocarbons 30%	1	1	2	2	6
Aromatic hydrocarbons 20%	1	1	1	1	4
Total	3	5	6	6	20

Kuder Richardson's (K20) formula was used to ascertain the reliability and it gave an index value of 0.80. Data collected were scored and analysed using descriptive statistics and Analysis of Covariance (ANCOVA).

Result and Discussion

Research question one:

What is the percentage of students with the correct conception of the concept of hydrocarbon before and after instruction based on the group?

Table 2: Percentage of students with correct conception of hydrocarbons before and after treatment based on groups.

	Experimental Group		Control Group	
	Correct Conception		Correct Conception	
	Before	After	Before	After
1	6.7	30.5	10.9	14.7
2	3.8	10.8	5.4	18.5
3	7.3	19.2	5.2	8.7
4	6.6	19.4	2.1	10.6
5	12.5	32.6	18.5	32.0
6	19.6	22.8	9.5	24.8
7	0.0	6.0	18.6	22.9
8	4.7	15.3	8.4	14.3
9	20.7	45.6	2.0	0.0
10	8.6	71.7	12.7	22.7
11	16.8	52.3	9.9	19.7
12	30.1	61.3	17.4	20.1
13	5,6	23.7	16.8	34.8
14	2.8	8.7	18.4	43.0
15	10.9	17.6	14.5	17.4
16	3.6	18.4	12.4	13.9
17	15.8	30.5	8.6	9.0
18	18.6	30.7	13.0	21.6
19	26.3	54.4	12.4	16.8
20	19.5	32.8	1.0	2.0

Table 2 above shows that the percentage of students with the correct conception of hydrocarbons in the experimental group on the pre-test ranges from 0.0 to 30.0 and the post-test ranges from 6.0 to 71.7. It also shows that the percentage of students with the correct conception of hydrocarbons in the control group on the pre-test ranges from 1.0 to 24.4 and on the post-test ranges from 2.0 to 34.8. This indicates that there are more students with the correct conception of hydrocarbons after instruction.

HO_1: There is no significant difference in the conception score on hydrocarbons between the students taught with role play analogy and control group students.

Table 3: Analysis of Covariance (ANCOVA) statistics showing the difference between students taught with a role play analogy and control group students' conception scores.

Source	Type III Sum of squares	df	Mean square	F	Sig.
Corrected Model	138.87	2	69.43	16.41	0.00
Intercept	362.49	1	362.49	85.69	0.00

Pre- Con	37.21	1	37.21	8.79	0.00
Group	81.24	1	81.24	19.20	0.00
Error	304.56	72	4.23		
Total	748.29	75			
Corrected Total	385.8	74			

Table 3 showed a significant difference between the experimental and control conception scores, F = 0.00, P = 0.00. Since the p-value of 0.00 is less than 0.05 level of significance, this shows that there is a significant difference. Therefore, the null hypothesis which stated that there is no significant difference in the conception score on hydrocarbon between the experimental and control group students was rejected.

HO_2: There is no significant interaction effect of treatment and sex on students' conception.

Table 4: Analysis of Covariance (Two-way ANCOVA) test showing the significant interaction effect of treatment and sex on students' conception.

Source	Type lll sum of squares	df	Mean Square	F	Sig.
Corrected Model	132.01	2	66.01	15.39	0.00
Intercept	364.69	1	364.69	85.01	0.00
Pre- Con	35.83	1	35.83	8.35	0.05
Sex	0.31	1	0.31	0.07	0.68
Group	82.00	1	82.00	19.11	0.00
Sex*Group	2.47	1	2.47	0.57	0.35
Error	300.25	70	4.29		
Total	785.55	75			
Corrected Total	420.86	74			

From Table 4, the analysis of covariance shows the calculated value of 0.35 which is higher than the critical value of 0.05. This indicates that there is no significant interaction effect between treatment and sex on students' conception. Hence, the null hypothesis which states that there is no significant interaction effect of treatment and sex on students' conception is retained.

Discussion of findings.

The findings of this study showed that after teaching, students' accurate conceptions of hydrocarbon increased, however when compared with the control group. Students in the experimental group had the highest conception scores.

The experimental group's increased correct conception may have resulted from the teaching technique that actively encouraged student participation in the process of teaching and learning.

Also, the findings of this study which included a significant conceptual difference between the experimental and control groups of students revealed that the experimental group outperformed the control group by a significant margin. This finding aligns with the findings of Olorundare and Aderogba (2009) and Okpala and Okigbo 2021 which found significant differences in favour of students taught with analogy than those of lecture method. It also supports Onwukwe (2010) who found that students taught with the simulation and analogies approach achieved better than those taught with traditional methods of teaching. In a similar vein, Okoli 2012 found that the

implementation of conceptual change in text-oriented education resulted in a greater rise in conception scores compared to conventional teaching methods.

Lastly, the finding of this study showed no significant interaction effect between the method of treatment and gender on students' conception. This indicates that students' conception was influenced by the activity-based educational technique regardless of their gender. These findings are in agreement with the findings of Baser (2006) who found no significant interaction effect between method and gender in the use of cognitive conflict-based instruction on students' understanding of heat and Ajayi (2013), Okeke (2017) who found a non-significant interactions effect between sex and method of instruction on achievements in biology and chemistry respectively.

Conclusion

Based on findings, it was concluded that using role-play analogy has positively influenced hydrocarbon conceptual understanding of chemistry students and the use of role-play analogy will be a suitable method for teaching chemistry in schools which will help chemistry teachers to effectively plan, prepare and present their lesson as well as enables students to be very active and think critically.

Recommendations

Based on the findings of the study, the following were recommended.

1. The curriculum developers should review their curriculum and include the use of role-play methods for effective teaching processes.
2. Government agencies and professional associations should organise seminars and workshops for chemistry teachers on the use of the role-play analogy method in teaching to enable them to capture the students' interest in each concept in chemistry.

References

Ajaja O.P. (2013). Which strategy best suits biology teaching? Lecturing concept- mapping, cooperative learning cycle? Electronic, Journal of Science Education, 17(1), 1-37.

Anyaegbunam, N.J. (2012). Effect of constructivist theatre instruction on students' knowledge of HIV. AIDs and sexual behaviour in the Enugu State of Nigeria Unpublished PhD Dissertation, Department of Science Education, University of Nigeria.

Eravwoke, O.U & Omoifo C.N (2020). Effect of activity-based instructional strategy incorporating role analogy on students' conceptual understanding and retention of Isomerism. African Journal of Studies in Education. University of Benin,15(1), pp 1- 18.

Jonassen, D.H. (2006), Modeling with technology: Mind tools for conceptual change. Upper Saddle River, New Jersey: Pearson Education Inc.

Okeke, A.C. (2017). Making Science Education Accessible to all. An Inaugural lecture, university of Nigeria Nsukka.

Okpala, U.V & Okigbo, C.E. (2021) Effect of Role play method on Secondary school students' interest in chemistry in Aguata Education Zone of Anambra State. South Eastern Journal and Sustainable Development (SEJRSD), 4 (1), 131 – 139.

Okoli, N. (2012). Effect of conceptual change instructional text on secondary school students understanding of electrochemistry. Unpublished PhD Thesis of University of Benin, Benin City.

Olorundare, A.M & Aderogba, A.A.(2009). Comparative effect of concept- -mapping, analogy and expository strategies on secondary school performance in chemistry in IIesa, Nigeria. Retrieved from www.google.com on 16th, June 2014.

Omoifo, C.N (2012). Dance of the limits – reversing the trend in science education in Nigeria. Inaugural lecture series 124, University of Benin, Benin City, Nigeria.

Onwukwe, E.O (2010). Combined effects of play-simulations and teaching with an analogy on secondary school students' achievement in chemistry. A Ph.D. Dissertation of the Faculty of Education, Nnamdi Azikwe University Awka, Nigeria.

Sahin, P.E.,(2010). Using analogies to prevent misconceptions about chemical equilibrium. Journal of Asia-Pacific Forum on Science Learning and Teaching 11, (2), 1-35.

Wu, H.,Krajcik, J.S. & Soloway.,E. (2000). Promoting conceptual understanding of chemical representations: Students use of a visualization tool in the classroom. A paper presented at the annual meeting of the National Association of Research in Science Teaching, April 28 - May 1, 2000, New Orleans, L.A.

Yadikar, K.T. (2004). The effect of activity-based role play on Ninth-grade students' achievement and attitude towards the simple electric circuit. Unpublished M.Sc. Thesis of Middle East Technical University.