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EFFECT OF ANIMATION AS AN INSTRUCTIONAL STRATEGY ON STUDENTS' ACHIEVEMENT AND RETENTION IN CHEMICAL BONDING

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Abstract

This study investigated the effect of animation instructional strategy on students' academic achievement and retention of chemical bonding among senior secondary school students in Otuocha Education zone of Anambra state. A pre-test, post-test, control group quasi-experimental design was adopted for the study. Two research questions and two null hypotheses were raised to guide the study. The population of the study was 6,234 SS1 students and a sample of 203 students was randomly selected. The Chemical Bonding Achievement Test (CBAT) was the instrument used for the collection of data for the study. The instrument was validated by three experts. A reliability index of 0.82 was obtained for the instrument using Kuder Richardson (K-R-20) for CBAT. The data obtained were analyzed using mean and standard deviation to answer research questions and Analysis of Covariance (ANCOVA) was used to test the hypotheses at $p<0.05$ level of significance. The findings from the study revealed that students who were taught chemical bonding using animation outperformed and retained the concept of chemical bonding than those taught using lecture method. Based on the findings, the researcher recommends among others that secondary school chemical teachers should embrace animation as an innovative teaching tool in the classroom for better achievement and retention of chemistry concepts. This will assist in reducing the poor achievement of students in chemistry in both internal and external examinations.

Key words: Animation, Achievement and Retention in Chemical bonding.

Introduction

Chemical bonding is a key concept in chemistry. Chemical bonding theories and models are central to other topics taught in chemistry curricula. Chemical bonding theories are the cognitive keys that students need to be able to visualize the microscopic world of chemistry and without which, it will be difficult for one to understand Chemistry (Taber & Coll, 2012). It is a topic area where understanding is developed through diverse models - which are in turn built upon a range of physical principles and where learners are expected to interpret a disparate range of symbolic representations standing for chemical bonds. Opara (2020) outlined the relevance of chemical bonding to life (because Chemistry is life) which ranges from the atoms of oxygen, carbon, hydrogen, and other elements of the human body to the existence of protein and carbohydrates, water, long duration of drug action, gas we use in our cars, etc and other aspects of Chemistry.

Unfortunately, despite the fact that chemical bonding holds a central position to other topics in Chemistry, students performed below average in this all important aspect of Chemistry in both internal and external examinations such as West African Senior School Certificate Examination (WASSCE) because of their inadequate understanding of the concept of chemical bonding. Statistics shows that mass failure in chemistry examination is real and the trend of students' achievement has been on the decline (Danjuma, 2015).

In spite of the research efforts to address the perennial poor achievement of students in Chemistry, Chief Examiners yearly reports have continued to highlight students' weaknesses in chemical bonding such as: poor computational skill, inability to differentiate between the chemical bonding, inability to balance chemical equation (SSCE May/June WAEC Chief Examiners' report 2017: 186). Again, candidates lost marks for the following reasons: omission of units/use of wrong units; inability to determine chemical bonds- ionic, covalent, metallic, and hydrogen bonds (SSCE May/June WAEC Chief Examiners' report 2018: 328). In addition, candidates exhibited the under listed weaknesses such as: inability to differentiate between the chemical bonding; writing formulae of compounds when the question requested for names (SSCE May/June WAEC Chief Examiners' report 2019: 344).

Researchers (Lawal, 2007; Atadoga, & Lakpini, 2013) found that the persistent low academic achievement in science education is attributed to teacher instructional strategies among others. Thus, instructional strategies used by teachers in teaching-learning process have significant influence on learners' academic achievement. Researchers had attempted to address the problem by proffering teaching methods to stimulate students' interest and retention (Okorie, 2015; Ameh, 2015; Akpoghol, 2016). Most of the methods though useful have as yet not succeeded in ameliorating students' difficulty in this very important aspect of Chemistry. There is need; therefore, to redirect Chemistry education research on instructional strategies towards innovative teaching methods. In this study, the researcher investigated the effect of animation instructional strategy on students' academic achievement and retention in chemical bonding.

Animation instructional strategy is a form of instructional method that implies the use of computer animation, graphic and cartoons in classroom instruction. It is the technique of photographing successive drawings or positions of puppets or models to create an illusion of movement when the film is shown as a sequence (Mayer & Moreno 2012). The scholars further refer animation as a simulated motion picture depicting movement of drawn (or

simulated) objects or as an image in motion. In educational terms, animations can be viewed as a technique of visualization. According to Sanchez, Canas, and Novak, (2010), educational animations are animations produced for the specific purpose of fostering learning.

Animation and digital maps were observed by Aremu and Sangodoyin (2010) as technological tools that make abstract concepts in sciences especially in Chemistry easier to understand and ensure that learning is permanent. For effective learning to take in the Chemistry classroom, it must be done through pictures and content together than the text alone. This was said to have made teaching and learning more active, interactive, and learner-centered which had guided instructors and practitioners away from the passive classroom where the learners are mere listeners towards creating a learning environment that motivates learners and enhances better learning situations. Multimedia learning is an effective way of learning in modern times as it attracts the attention of the learners and helps them develop their understanding related to particular subjects. Amal and Samar (2018) found that the use of animation in education has significantly increased the attitudes and academic achievements of the students in a positive way. It has been shown from several research reports such as Kasali (2010) and Wishart (2014) that animations as technological tools used in education have contributed a lot to the students' fulfillment of cognitive function. In this role, animations are intended to support students' cognitive processes that ultimately result in them understanding the subject matter, simplifying complicated systems and motivation as well as providing a significant increase in students' attitude and academic achievements towards the courses in a positive manner (Muhammad, Mohamaad, & Nugrahaningsih, 2017). Basak, Yucehan, and Ahmet (2018) described animation as an effective learning tool that attracts attention, engages learner, and sustains motivation and enhance retention of concepts that results in meaningful learning. It also includes the use of interactive elements such as graphics, text, video, sound, and cartoon teaching (Nweke, 2010).

Literature Review

The search for new and innovative ways to educate learners for meaningful learning in sciences is on the increase. A research report by Goff et al (2016) described animation as a teaching tool that allows learners have fun and that learners tend to learn better and retain information higher as a training medium that offers exciting possibilities for meeting the needs of 21st-century learners. Amal and Samar (2018) investigated the effect of computer animation via movies on the Biology academic achievement among students of the Faculty of Educational Sciences and Arts/UNRWA (FESA). The population of the study consisted of all the students of the Faculty of UNRWA Educational Sciences and Arts (FESA) enrolled for the year 2017-2018. The sample consisted of all 70 students enrolled in the Biology course for the year. A 40 items test was administered to assess students' academic achievement in Biology. The study adopted a pre-test post-test control group quasi-experimental design. The findings from the study revealed that students taught with animation have higher achievement in Biology than those taught with the lecture method. This implies that animation had a positive effect on students' achievement in Biology generally.

Nungwo et al. (2017) investigated the effects of animation on students' academic achievement and retention in Basic Electricity at Technical Colleges in Benue State. The two groups of

students were treated with animation instructional techniques and conventional teaching methods respectively. The findings of the study revealed that students taught with animation have higher achievement and retention in Basic Electricity than those taught with the conventional teaching method. A similar study was carried out by Falode, Solowale, Usman, and Folade (2016) on the effectiveness of computer animation instructional package (CAIP) on academic achievement of senior secondary school agricultural science students in animal physiology in Minna, Nigeria; and the influence of gender was also examined. A pre-test post-test control group quasi-experimental design was adopted for the study. The sample of the study was made up of 88 senior secondary school students selected from intact classes of two co-educational public schools who were randomly assigned to experimental and control groups. The experimental group was taught through CAIP while the control group was taught using the lecture method. The finding of the study revealed that there was a significant difference between the mean achievement scores of the two groups in favour of those taught with CAIP. Also, the package improved the achievement of both male and female students taught.

Salisu (2015) carried out similar research on the impact of animated-media strategy on achievement, retention, and interest among secondary school Geography students in Weather Concepts in Katsina State, Nigeria. The population of the study was 699 students which 116 students were randomly selected as participants of the study. A pre-test post-test quasi-experimental design was adopted for the study. Participants were grouped into two comprising of the experimental group and the control group. Weather Concepts Achievements Test (WCAT) and Weather Concepts Interest Questionnaire were administered to the participants as instruments for the data collection. The research findings revealed a significant difference in the academic achievement of subjects exposed to the animated media strategy and those taught using lectures in favour of animated media strategy. There were also significant differences in the retention and interest of subjects exposed to the same strategy and those taught using the lecture method.

Statement of Problem

Chemistry is an important branch of science that serves as a prerequisite for most professional courses in the science field. Several research reports revealed that the performance of the students in the subject at secondary school level has persistently been on the decline in both internal and external examination. However, different factors had been identified to be responsible for this trend. Some of the factors include the abstract nature of Chemistry concepts such as chemical bonding are identified to be difficult to teach and learn, the method employed by the teachers in the explanation of these concepts (among others) remains a problem. Also Chief Examiners have reported persistent candidates' weakness in chemical bonding which the failure rate was attributed to the use of teaching techniques as reported by Ghulam, et al (2018). One major challenge facing Chemistry teachers is their inability to explore and adopt new innovative teaching strategies that will be attractive to student which will not only draw students to learning Chemical bonding but also enhance their achievement in the subject. There is, therefore, a need for secondary school teachers to embrace innovative technology in classroom practice that ensures the understanding of these abstract processes in Chemistry. It is against this background that this study attempts to find the effect of animation as an instructional strategy on the achievement and retention in Chemical bonding among senior secondary school students of Otuocha Education zone, Anambra State, Nigeria.

Research Questions

1. What is the difference in the achievement of senior secondary school students in chemical bonding when taught using animation and those taught with the lecture method?
2. What is the difference in senior secondary school students' retention in chemical bonding when taught using animation and those taught with the lecture method?

Hypotheses

1. There is no significant difference in the achievement of senior secondary school students in chemical bonding when taught using animation and those taught with the lecture method.
2. There is no significant difference in retention of senior secondary school students in chemical bonding when taught using animation and those taught with the lecture method.

Methodology

This study adopted a pre-test, post-test, control group quasi-experimental design with the subject of the study assigned to experimental and control groups. A pre-test was conducted to determine the entry equivalent of the two groups. The experimental group (EG) received treatment using animation strategy while the control group was taught the same chemical bonding using lecture method. The research design is represented in the table 1.

Groups	Pre-test	Treatment	Post-test	Post post-test
Experimental Group	Q_1	X_1	Q_2	Q_3
Control Group	Q_1	X_2	Q_2	Q_3

Where Q_1 is pre-test score; Q_2 is post-test score; Q_3 is post post-test score.

X_1 is Animation Strategy Treatment and X_2 is Lecture method (as control treatment)

Sample and Sampling Techniques

Two public senior secondary schools were purposively selected for the study, the schools were selected on the basis that they have equipped computer laboratory and source of power which serve as the basic pre-requisite for the running of the PowerPoint projector that was needed for the display of animation in the experimental group. Participating students were selected from SS1 using the conventional sampling method with intact class. The sample for the study consisted of all the study in the two intact classes because the two classes offer Chemistry as science students. The two schools were randomly assigned to serve as experimental group and control group.

The sample for the study consisted of all the 203 students in the two intact classes from the two public senior secondary schools selected in Otuocha Education Zone. The experimental group consisted of 97 students while the control group is made up of 106 students. The experimental group was taught chemical bonding using animation while the control group on the other hand was taught the same chemical bonding using the lecture method.

Instrumentation

Two research instruments were developed and used for the study.

Instrument for Treatment

Animated videos on chemical bonding were adopted and used as a treatment for the experimental group. The videos were downloaded and reconstructed by the researcher and a computer programmer to suit the teaching. The animated videos were structured into eight lessons focusing on the different types of chemical bonding with different examples. The animated videos were designed to reflect the various happenings or processes at each chemical bond. The animation was structured into slides carrying narration and voiced over which were played via PowerPoint by the researcher.

Instrument for Data Collection

The instrument for data collection was the Chemical Bonding Achievement Test (CBAT) which was developed by the researcher drawing questions on various aspects of chemical bonding to test the performance of the students. The instrument contained 50 multiple choice questions from past West African Secondary School Certificate Examination (WASSCE) and National Examination Council (NECO) Chemistry Paper 2 May/June, from 2010-2020 as a model. The same instrument was re-administered to determine the retention ability among the experimental and control groups.

Method of Data Collection

A pre-test of the Chemical Bonding Achievement Test (CBAT) was conducted for both experimented and control one week before the commencement of the treatment sessions of the study. The experimental group was taught chemical bonding using the designed animated videos while the control group was exposed to the same concepts using the lecture method. The teaching exercise lasted for four weeks in both groups; the teaching sessions were performed by the researcher to ensure the integrity of the research work. At the end of the treatment, a post-test was administered to both groups to determine the performance of the students in chemical bonding, two weeks later, and a post-test was conducted to both the experimental and control group to determine the retention ability of the students.

Method of Data Analysis

The pre-test and post-test scores of the students were analysed using a statistical package for social sciences (SPSS) version 20. The significance of the statistical analysis was tested at 0.05 alpha-level. Mean and standard deviation was used in answering the research questions while the ANCOVA statistical technique was used to test the two null hypotheses.

Presentation and Discussion of Results

Research Question 1

What is the difference in the achievement of senior secondary school students in chemical bonding when taught using animation and those taught with the lecture method?

Table 2: ***Mean and Standard Deviation Scores of the Achievement Scores for Students Taught Chemical Bonding Using Animated Instructional Strategy and Those Taught Using Lecture Method.***

Strategy		PRETEST		POSTTEST		GAIN	
	N	Mean	SD	Mean	SD	Mean	SD
Experimental	97	15.89	3.851	36.56	6.85	20.67	3.01
Control group	106	15.70	3.841	20.01	5.52	4.31	1.97

Table 2 showed mean and standard deviation of the achievement scores for the experimental and control groups. From the result, the mean achievement score and standard deviation of students taught Chemical bonding with Animated Instructional Strategy were 36.56 and 6.85 respectively. These gave a mean gain score of 20.67. Similarly the mean achievement score and standard deviation of students taught Chemical bonding using Lecture Method were 20.01 and 5.52 respectively. These gave a mean gain of 4.31. The result indicates that students taught Chemical bonding with Animated Instructional Strategy performed better than students taught using Lecture Method.

H_{01}: There is no significant difference in the achievement of senior secondary school students in chemical bonding when taught using Animation and those taught with the Lecture Method.

Table 3: ***Analysis of Covariance (ANCOVA) of the Mean Achievement Scores of Students Taught Chemical Bonding Using Animation Instructional Strategy and Lecture Method.***

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	40654.244[a]	2	20327.100	92.431	.000	0.441
Intercept	173938.900	1	173939.000	790.931	.000	0.772
Pretest	3597.154	1	3597.150	16.357	.000	0.065
Groups	37805.549	1	37805.500	171.908	.000	0.424
Error	51460.524	200	219.917			
Total	937831.250	203				
Corrected Total	92114.768	203				

a. R Squared = .441 (Adjusted R Squared = .437)

The data presented in Table 3 showed F-calculated values for test of significance between the mean achievement scores of students taught chemical bonding using animated instructional strategy (experimental) and those taught with lecture method (control) to be $F_{(1,234)}$= 171.91, p= .0005. η^2= .42. Since the probability value of .000 is less than the .05 level of significance, the null hypothesis was rejected. This implies that there is statistically significant

difference between the mean achievement scores of students taught Chemical bonding using Animation Instructional Strategy and those taught using Lecture Method in favour of experimental group.

Research Question Two

What is the difference in senior secondary school students' retention in chemical bonding when taught using animation and those taught with the lecture method?

Table 4: ***Mean Retention and Standard Deviation Scores of Students taught Stoichiometry using Animation Instructional Strategy and those taught using Lecture Method.***

Strategy		**PRETEST**		**RETENTION-TEST**		**GAIN**
	N	**Mean**	**SD**	**Mean**	**SD**	**Mean**
Experimental	97	15.89	3.851	24.33	1.77	8.44
Lecture	106	15.70	3.841	17.23	2.32	1.53

The results in Table 4 reveal that, the pre-test mean scores for animation instructional strategy and lecture groups are 15.89 and 15.70 respectively with their standard deviation scores of 3.851 and 3.841 respectively. The retention test mean scores were 24.33 and 14.23 respectively with their standard deviation scores of 1.77 and 2.32 respectively. The mean difference between the two groups was 6.91 in favour of Animation Instructional Strategy group. This implies that the experimental group has higher retention rate than the control group. That is, the mean retention of students taught using Animation Instructional Strategy was higher than those taught using lecture method.

HO_2: There is no significant difference in the retention of senior secondary school students in chemical bonding when taught using animation instructional strategy and those taught with the lecture method.

Table 4: ***Analysis of Variance (ANOVA) Results of the Achievement and Retention Test of Students' Taught Chemical bonding using Cooperative Group Learning Strategy and Conventional Strategy***

Source of Variation	**Sum of Square**	**DF**	**Mean Square**	**F**	**Sig.**
Corrected Model	5445.364	3	1815.121	89.340	.000
Intercept	54857.311	1	54857.311	2701.281	.000
Treatment group	226.580	1	226.580	11.157	.001*
Gender	3596.019	1	3596.019	177.075	.000
Treatment Group x	69.194	1	69.194	3.407	.066
Error	5401.899	266	20.308		
Total	82323.000	270			
Corrected Total	10847.263	269			

*Significant at 0.05 alpha level

The analysis in table 4 showed a significant difference in the achievement and retention of students taught chemistry with cooperative group learning strategy and those taught with conventional learning strategy in favour of cooperative group learning strategy. (F-cal = 11.157, p= 0.001*).

Therefore, the null hypothesis which states that there is no significant difference in achievement and retention between students' taught chemistry using cooperative group learning strategy and those taught with conventional learning strategy at 0.05 level of significance is rejected. This implies that cooperative group learning strategy significantly affected students' academic achievement and retention of chemistry concepts.

From the results in table 4, the experimental group had a higher mean than control group. This therefore indicated that cooperative group learning strategy aids achievement and retention more than conventional learning strategy.

The findings of this study were as follows:

1. There is no significant difference in the pre-test scores of both experimental and control group students. This result shows that both groups have the same prior knowledge of chemical bonding before the treatment commenced.
2. Animation as a teaching tool was found to promote students' achievement in chemical bonding better than the use of the lecture method. This is because the experimental group taught using animation outperformed their control group counterpart.
3. The experimental group that was taught using animation was found to retain the concept better than the control group; the mean difference observed in the test of retention was in favour of the experimental group.

Conclusion and Recommendation

The study concluded in the light of the above findings that since students who were taught chemical bonding using animation outperformed their counterpart taught using lecture method with limited time, it will improve students' achievement and retention in other aspects of Chemistry when used by the teachers as a main teaching method in the classroom. It is, therefore, recommended among others that animation as an innovative teaching method be adopted by Chemistry teachers at secondary schools; and that students should be encouraged to explore the opportunities offered by animation as an instructional tool to engage in the individualized study since it has been found effective and capable of improving retention of concepts in Chemistry.

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