

EFFECT OF CONCEPT MAPPING INSTRUCTIONAL STRATEGY ON STUDENTS' ACHIEVEMENT IN CHEMICAL BONDING IN FCT ABUJA, NIGERIA

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Abstract

This study investigated the effect of concept mapping instructional strategy on students' achievement in chemical bonding in FCT Abuja. Two research questions guided the study and two null hypotheses were formulated and tested at 0.05 confidence level. Quasi-experimental design was used for the study which involved two intact classes as the experimental and control groups. The population for the study comprised 1,285 (615 male and 670 female) SS1 Chemistry students from public secondary schools in Bwari Area Council of FCT. Simple random sampling was used to draw a sample of 94 students for the study. Chemical Bonding Achievement Test (CBAT) with a reliability index of 0.78 and was used for data collection. The data obtained were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The findings of the study revealed that teaching chemical bonding using concept-mapping instructional strategy (CMIS) had 0.003 enhances students' mean achievement. The findings also show that: using concept mapping to teach students chemical bonding has a significant effect on their achievement scores. Gender has no significant effect of students' achievement. Based on the findings of the study it was recommended among others that, chemistry teachers should be encouraged to develop and adopt concept-mapping.

Keyword: Concept mapping strategy Academic Achievement, Chemical Bonding

Introduction

The 21st century is characterized by enormous advancement in Science and Technology. For Nigeria to realize accelerated development in the 21st century, she needs qualitative science and technology education in its schools especially at the junior secondary school level which invariably is the foundation for advanced science and technology education (Omorogbe & Ewansiha, 2013). In a developing country like Nigeria, the importance of Science and Technology education cannot be overemphasized. This is because it helps to ensure continuous availability of students in expected number who take important science and technology related advanced careers (Samuel, 2017). From the foregoing, Nigeria as a developing nation is in dire need of

scientifically and technologically literate citizenry to be able to catapult her to the level of developed nations and to address the aspiration of the country to be among the first 20 economically developed countries in the world by the year 2020 (Achimugu, 2016).

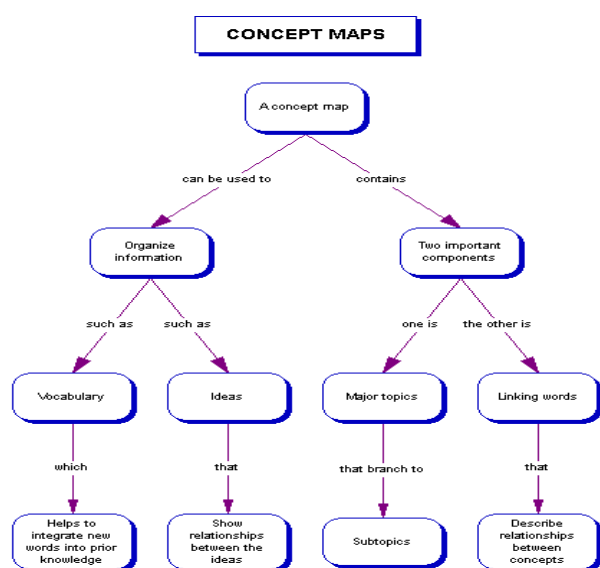
The prominence of science is secured on chemistry as one of the core basic sciences for scientific and technological development. Chemistry as a course is one of the basic requirements for studying science and technology courses at tertiary institutions. Chemistry is one of the branches of pure science and it occupies a pride of place in senior secondary school (SSS) curriculum in Nigeria. Chemistry deals with the composition, properties and uses of matter (Ababio, 2013). It is a science of molecular behavior. The importance of chemistry as a basic prerequisite for economic, scientific and technological development of any nation cannot be over emphasized especially in Nigeria where the national income rest on petroleum and petrochemical industries.

Chemistry cannot be isolated from our lives. Chemistry has contributed greatly towards providing our basic needs and improving the quality of our life. This can be felt and seen in the area of food, medicine, clothing, housing, transportation, detergent, fertilizer among other, Chemistry enables learners to understand what happen around them. However, chemistry has often proven to be a difficult subject for many learners and fazui and mitalistiani (2018) The root of many difficulties that students have in learning is traceable to inadequate understanding of basic elementary concepts such as valences,

chemical formula, chemical equation ; as West African Examination Council (WAEC) Chief Examiner's report 2010 and 2012 shows that most of the chemistry candidate displayed inability to accurately write down chemical formula and balance simple equations. The concepts of formulae and equation have been recognized as some of the basic chemical concepts. Despite all the importance of chemistry as a key science subject, it was revealed that poor achievements of students have consistently been reported in External Examinations (West Africa Examination Council, WAEC, 2011 - 2017) and Chief Examiners report of (NECO, 2016). Chemistry being one of the basic science subjects in which students perform very poorly may be due to many factors - such as mathematical aspects of chemistry, poor teaching methods and strategies, students' negative disposition and lack of interest in the subject, (Omiko 2017). This is based on the fact that chemistry as a subject is a pre-requisite for many science and technology related courses such as medicine, engineering, pharmacy among others in tertiary institution. Records from WAEC Research and Statistic Unit from 2013-2018 revealed a trend of low achievement of students in chemistry.

From the year 2013 to 2018, the performance of students in chemistry has been below average. This problem of low achievement of chemistry students put to question the teaching and learning of chemistry in our classroom and is of great concern to major stakeholders in Chemistry Education. This trend is unhealthy for attainment of the national goals for technological

advancement and economic reconstruction. Students' poor performance in chemistry might probably be associated with some concepts that are perceived by students as difficult (Uchegbu, Oguoma, Elenwoke & Ogbuagu, 2016). This is why instructional strategies development and improvement is more important to the improvement of science education teaching than other field of knowledge. There are various types of mapping instructional strategies among which are mind mapping (MM), Vee-mapping (VM) and concept mapping (CM) (Jegede, Alaiyemo & Okebukola 1990). Ogwo & Oranu (2006) defined concept mapping as a working instrument for establishing and demonstrating knowledge. Concept mapping according to agama (2013) describe CM as an instructional strategy used to aid learning by explicitly integrating old and new knowledge, simplifying complex idea representing information visually, designing a complex structure, asses understanding or diagnosing misunderstanding and generating ideas through brain storming.



CM includes concepts, usually enclosed in

circles or boxes to show relationships between concepts or propositions as indicated by a connecting line between two concepts (Novak, 2002). (Dori & Hamairi, 2013). In the studies made about chemical bonds, it is figured out that students are in difficulty in understanding the types of chemical bonds, they confuse intra and intermolecular bonds, and they have misconceptions about the bond and molecule polarity, molecular structure and the network of the matter Concept mapping is a classroom activity, which involves making of a diagrammatic representation of the relationship between the major concept (topic) and the subordinate (minor) concepts in a hierarchical order schmid and talaro (2015). In fact, Novak and Gowin (2005) see Ausubel's theory as a sound intellectual foundation for concepts mapping, as the strategy enhances students' meta-knowledge and meta-learning.

Achievement refers to the outcomes or gains from instructional delivery. Achievement is therefore a fundamental aspect of everyday life, affecting peoples work, interpersonal relationships, sense of being and leisure. The quintessential, achievement oriented domain in education particularly for college students, includes high performance on tests, passing

courses, and completing degrees. Academic achievement is the outcome of education, the extent to which a student, teacher or institution has achieved their educational goals. Academic achievement is commonly measured by examination or continuous assessment but there is no general agreement on how it is best tested or which aspects are most important procedural or knowledge such as skills or declarative knowledge such as facts.

Gender is also an important issue in science education especially with increasing emphasis in ways of boosting man power for technology fields (Isah, 2013). Gender involves the physical and behavioural difference that distinguishes individual organism according to their functions in the reproductive process. The performance of Chemistry students among male and female students have been discovered to vary significantly in favour of male students (Otor, 2011). Similarly, Adeyemi (2003) indicated that some teaching methods are gender sensitive. While Bilesanmi – Awoderu and Oludipe (2012) indicated that teaching methods are not gender sensitive.

There have been series of public outcry on students' poor performance in Chemistry and

inability of graduates to translate and apply what they have learnt in the classroom to real life situations. Besides, external examination results in Chemistry have shown a high rate of failure especially among senior secondary school students caused by some observable weaknesses. The reports of the Chief Examiners for Chemistry revealed lapses in students enrolling for chemistry in the last five years; 2013 to 2018. They revealed students' inability to adhere to rubric (instructions) which shows their lack of understanding of the basic requirement of Chemistry. They commented on students' lack of understanding of the demands of the questions and rampant spelling mistakes and poor communication which also shows that the basic concept of Chemistry are not yet conceived and mastered by the students. The search for explanation of students' poor performance in schools is far from being concluded as it remains one major controversial issue in education.

To teach chemistry, a good understanding of the subject matter is important, because teaching is more than just a process of transferring information from teacher's notes to the students'. Appropriate communication of the body of knowledge and logical organization of its

structure is a task Chemistry teachers are facing in the classroom. Chemistry, by nature, contains a lot of abstract terms and concepts; therefore, students need a lot of time to commit them to memory. Teaching Chemistry in such a way that meaningful and sustainable learning takes place through the use of right methods and strategies is a major problem of chemistry teachers. It has therefore become necessary to try out such innovative strategy such as Concept Mapping to ascertain their on students' interest, achievement and retention towards chemistry, especially using it in chemical bonding.

Objectives of the Study

This study determined the effect of concept mapping instructional strategy on students' achievement in chemical bonding in FCT Abuja.

The specific objectives of this study are to:

1. To determine the achievement of chemistry students taught chemical bonding using concept mapping instructional strategy (CMIS) and those taught with lecture method?.
2. To determine the achievement of male and female chemistry students taught chemical bonding using CMIS.

Research Questions

The following research questions were raised for the study

1. What are the mean achievement scores of chemistry students taught chemical bonding using Concept Mapping Instructional Strategy (CMIS) and those taught with lecture method?
2. What are the mean achievement scores of male and female students taught chemical bonding using CMIS?

Statement of the Hypotheses

The following null hypotheses are formulated and will be tested at 0.05 level of significance.

H₀₁: There is no significant difference in the mean achievement scores of chemistry students taught chemical bonding using Concept mapping Instructional Strategies (CMIS) and that taught using lecture method.

H₀₂: There is no significant difference in the mean achievement scores of the female and male chemistry students taught chemical bonding using CMIS.

Methodology

This study adopted quasi-experimental research design, pre-test, and post-test, there will be no randomization. Quasi-experimental research design is used when it is not possible to

randomize individuals to treatment and control groups. The intact classes will be assigned to two groups namely; Experimental groups E1 and E2. The target population of the study consist of 1,285 (615 male and 670 female) SS1 Chemistry students from public secondary schools in Bwari Area Council of FCT. The common characteristic of the population is that they are all Senior Secondary science students who offer chemistry as a subject. Out of the eleven schools' co-educational seniors' school offering chemistry as a subject, two public co-educational secondary schools were selected, which are Government Secondary School Deidei and Government Secondary School Mpape using simple random sampling, two intact classes from the two sampled schools were taken to be the experimental group and the Control group and were assigned E1 and Experimental group E2 through a simple toss of a coin.

Result

The results of the analyses are presented in the order of the research questions and hypotheses of the study.

Research Questions One

What are the mean achievement scores of chemistry students taught chemical bonding using concept mapping instructional strategy (CMIS) and those taught with lecture method?

The instrument used for data collection was the Chemical Bonding Achievement Test (CBAT), which comprised 20 multiple choice objectives question. These test items were drawn from past Unified Tertiary Matriculation Examination (UTME) and Senior Secondary Certificate Examination (SSCE) past questions on chemical bonding. The instrument was used as a pretest (CBAT) and post-test (PCBAT). The post-test CBAT was used to determine the student's achievement

The data obtained from Chemical bonding Achievement Test (CBAT) were collated and analyzed using mean and standard deviation to answer the research questions and ANCOVA was used to test all the hypotheses at 0.05 levels of significance.

The mean achievement scores and standard deviations of chemistry students taught chemical bonding in chemistry with CMIS and those taught with LM are represented in table 1

Table 1: Mean Achievement Scores and Standard Deviations of Chemistry Students Taught Chemical Bonding using Concept Mapping Instructional Strategy (CMIS) and those Taught Using Lecture Method (LM)

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
LM	46	26.30	2.457	31.09	3.061	4.79
CMIS	48	27.54	2.895	33.92	3.99	6.38

Table 1 shows the Mean Achievement Scores and Standard Deviations of chemistry students taught chemical bonding using CMIS and those taught with LM. CMIS had the higher mean gain of 6.38 while LM had the mean gain of 4.79.

Hypothesis One

There is no significant difference in the mean achievement scores of chemistry students taught chemical bonding using Concept Mapping Instructional Strategies (CMIS) and those taught using lecture methods.

The ANCOVA for this hypothesis provided the data on Table 1.1.

Table 1.1: Results of Analysis of Covariance on Students' Achievement in Chemical Bonding Using Concept Mapping and Lecture Method (LM)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	580.284 ^a	2	290.142	33.801	.000
Intercept	127.406	1	127.406	14.843	.000
Pretest	392.198	1	392.198	45.691	.000
Group	78.762	1	78.762	9.176	0.003
Error	781.120	91			
Total	100844.000	94			
Corrected total	1361.404	93			

The table shows a significant difference in the mean achievement scores of chemistry students taught chemical bonding with Concept mapping and those taught with LM instructional strategies. $F =$ ratio of 9.176 was obtained with associated exact probability value of 0.003. Since the associated probability (0.003) was less than 0.05 set as level of significance, the hypothesis was rejected. The result implies that

the method of instruction produced a significant effect on the posttest achievement scores of students when pretest was controlled. The result indicated that the treatment using Concept mapping instructional strategy accounted for the difference in the posttest achievement scores of the students. Hence, there was a significant difference among the two groups of concept mapping and lecture method.

Research Question Four

What are the mean achievement scores of male and female students taught chemical bonding using CMIS?

The mean achievement score of male and female in chemical bonding taught using CMIS is represented in table 2

Table 2: Mean Achievement Score of Male and Female in Chemical Bonding Taught Using Concept Mapping

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	26	26.72	2.830	33.62	4.196	6.90
Female	22	27.45	3.035	33.92	3.820	6.47

The table shows the mean achievement scores of male and female in chemical bonding taught using concept mapping. The male had a mean

gain of 6.90 while the female had a mean gain of 6.47.

Hypothesis Two

There is no significant difference in the mean achievement scores of the female and male chemistry students taught chemical bonding using CMIS.

The ANCOVA for this hypothesis provided the data on Table 2.1

Table 2.1: Results of Analysis of Covariance on Male and Female Students' Achievement in Chemical Bonding Using Concept Mapping Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	95.408 ^a	2	47.704	6.288	0.004
Intercept	73.351	1	73.351	9.668	0.003
Pretest	95.402	1	95.402	12.574	0.001
Gender CM	9.507	1	9.507	1.253	0.269
Error	326.244	43	7.587		
Total	44876.000	46			
Corrected total	421.652	45			

Table 2.1 shows a significant difference of students' achievement taught using concept mapping based on based. $F =$ ratio 1.253 was obtained with associated exact probability value of 0.269. Since the associated probability (0.269) which is greater than 0.05 set as level of significance, the null hypothesis was accepted. The result implies that there was no significant difference in the mean achievement score of male and female student taught chemical bonding using concept mapping. This indicates

that the experimental group taught chemical bonding using concept mapping instructional strategy accounted for the difference in the achievement scores of the students.

Discussion of Findings

This study investigated the effect of concept mapping instructional strategy on students' achievement in chemical bonding in FCT Abuja.

The result of hypothesis one revealed significant difference between the achievement of students in of concept mapping and concept mapping

instructional strategies, it revealed a significant difference between the achievement of students in concept mapping and concept mapping instructional strategies in favour of concept mapping instructional strategies. The findings on students' achievement in the concept mapping and concept mapping instructional strategies is in agreement with Esiobu and Soyibo (2008) who conducted a study to determine the effect of concept and concept mappings under three learning modes on students' cognitive achievement in ecology and genetics. The result from the study showed that those taught with chemical bonding using concept mapping achieved significantly better than the control group taught chemical bonding using lecture method. The trend of improved achievement by the treatment groups could be as a result of the enabling learning environment provided where students were motivated using the chats provided helping and encouraging one another to learn.

The result of hypothesis two showed that there was no significant difference in the mean achievement scores of the female and male chemistry students taught chemical bonding with concept mapping instructional strategy, the

result showed that gender is not a determinant of the experimental group, that is, both male and female students' taught chemical bonding using concept mapping instructional both achieved equally, this findings is in disagreement with Polancos (2012) carried out a study on the results of an experiment that compared the effectiveness of the use of Vee Diagrams against that of Concept Maps in learning chemistry concepts, he stated that male counterpart outperformed the female counterpart

Conclusion

The findings of this study revealed that student taught using concept-mapping instructional strategy performed better than those taught using lecture method. These results imply that the instructional approaches employed by Chemistry teachers in teaching chemical bonding might have been partly accountable for the persistent underachievement of students in chemical bonding in senior secondary school one (SSI) students in Bwari Abuja. The implications of this study hinges on the development of more virile instructional approaches for teaching chemical bonding. Therefore, Chemistry teachers who teach chemical bonding should

attempt to employ student-centered instructional strategies like concept mapping instructional Strategies other than the conventional approaches since the latter is not student-centered.

Recommendations

The following recommendations were made based on the findings of the study:

1. Chemistry teachers who teaches chemical bonding should be encouraged to develop and adopt concept-mapping instructional strategy so as to improve class room interaction which will fasten and enhance students' overall achievement and retention
2. Chemistry students should always be encouraged to work together in mixed sex groups so as to help reduce gender gap and to enable them imbibe the culture of working cooperatively in order to promote their understanding.
3. Concept-mapping instructional strategy should be including in the curriculum by curriculum planners in the new national curriculum, so as to enhance the

teaching and learning of chemical bonding.

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