



## EFFECT OF AGE ON RETENTION ABILITY OF CHEMISTRY STUDENTS EXPOSED TO E-LEARNING INSTRUCTION IN INORGANIC CHEMISTRY

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### Abstract

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This study examined the effect of age on the retention ability of chemistry students exposed to e-Learning instruction in Inorganic Chemistry at the National Open University of Nigeria (NOUN). A total of 45 students formed the sample of the study from a population of 453 students. Purposive sampling technique was used for choosing the centre and sample used for the study. The study used the One Group Pretest, Posttest, Post-Posttest pre-experimental design. Participants were taught selected concepts in Inorganic Chemistry using the e-Learning instructional strategy for a period of eight weeks. An instrument, Chemistry Achievement Test (CAT) was used to collect data; its reliability coefficient was 0.78. A research question was answered and null hypothesis was tested, using the One Way Analysis of Variance (One Way ANOVA) at  $P < 0.05$ . The major finding from the study was that there was no significant difference in the retention ability of subjects of different age groups in the study. Based on the findings, it was concluded that retention ability of students taught using the e-Learning instructional strategy does not depend on age. It was recommended that NOUN, Distance Learning Institutes and institutions of higher learning should incorporate/adapt the instructional Strategy for the teaching of chemistry. Students and teachers should also be regularly trained and retrained on the usage of e-learning platforms.

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**Keywords:** *eLearning, retention ability, age grouping, Open and Distance Learning.*

## **Introduction**

This study investigated the effect of age on retention ability of chemistry students exposed to the e-Learning instruction in Inorganic Chemistry at the National Open University of Nigeria (NOUN). The National Open University of Nigeria is a full-fledged Open and Distance Learning (ODL) institution in Nigeria which uses the lecture method of instruction in form of printed media and tutorial sessions as well as technologically mediated learning/interactive learning or eLearning for imparting scientific facts and principles to her distant learners.

Over the last twenty years, according to Fox (2003), technology has reorganised how we live, how we communicate and how we teach. This view was also echoed by Jegede (2005) who had opined that the world was basking in the glory of numerous technological breakthroughs in the field of ICT's and that NOUN was poised to take advantage of that by incorporating the eLearning instructional strategy into its instructional arsenals. It is worthy to note that (McDonald & Stuart Hamilton, 1996; Jande, 1998; Kanwar, 2008 and Muwange - Zake, 2008) had informed that Africans are likely to find computers in adulthood, as such older people are less inclined to use ICT, which incidentally is the bedrock of eLearning. Jande (1998) had also asserted that "other factors apart from instructional method also affected learning. Among the factors listed were the learners' characteristics such as his/her age, needs/desires for learning, sex and his/her health".

Kanwar (2008) had described the youths of this generation as 'digital natives' who are born into technology and find it easier to comprehend and operate ICT tools of nowadays, in comparison to the older people who are designated as 'digital migrants'. They on the other hand, have to learn how to manipulate these ICT tools and most at times have difficulties comprehending and fully manipulating these gadgets, she had asserted.

It is pertinent to note that unlike the conventional universities where the average age of entrants is about 18 years, the National Open University of Nigeria offers admission to students within varied age range. In view of that, the clientele of the university is diverse, cutting across all age range from the young, through the intermediate age group to the adults, hence the desirability of this study. However, literature and studies relating age

grouping to academic achievement/retention ability in science are few and difficult to come by, because not much research has been carried out on it, but the concept is important to this study. Indeed, Paul and Stegbauer (2005), held the view that the acceptance and diffusion rate of technology among the elderly though can be said to be witnessing an increase continues to lag behind the figures observed for the younger users.

On the contrary, DiBiase and Kidwai (2010) investigated the counter-intuitive observation that older students seem to do better than younger students in online classes. They used a variety of measures in comparing the performance and attitudes of younger and older adults in separate but similar classes facilitated by the same instructor in a university in the United States over a period spanning nine months. Findings of the study were congruent with theoretical projections on the differences in readiness between younger and older adults for self-directed learning experiences. The notion that the ability to learn is at the highest ebb at a young age tapering off at a slow pace subsequently could be considered as true in most individuals, but it is actually too simplistic and in the final analysis a deficient visualisation of the effects of aging on a process as complex as learning (Crawford, 2004).

A definition for the concept of retention by Hornby (2005) is simply that it is the ability to remember things. When concepts are taught, the ultimate desire of every teacher is that they are remembered. Kwon Allen and Rasmussen (2005) were of the view that retention of knowledge was an important aspect of research that has the potential of informing instructional practices and school learning goals. This position was earlier averred to by Abu & Flowers (1997) and also maintained by Kamuche and Ledman (2005) and Achor, Imoko and Uloko (2009).

Some scholars had in the past attempted to establish a relationship between technologically mediated learning /interactive learning or eLearning and retention ability. Miller (1990) stated that in a learning situation, the process of interaction with materials been studied provides a strong learning reinforcement. This significantly increased content retention over time, particularly with interactive courses in comparison with traditional methods. Obringer (2001) also informed that eLearning can incorporate many elements that make learning new materials more fun or interesting, resulting

in a better retention of the learnt materials. In a report titled 'Corporate eLearning: Exploring A New Frontier' by Bachman (2000), it was informed that the average content retention rate for an instructor-led class was 58%, but a more intensive eLearning experience enhanced the retention rate by 2560%. A study was carried out by Abu and Flowers (1997) on the effect of cooperative learning approach on Students Teams-Achievement Divisions (STAD) on the achievement of content knowledge, retention and attitude of home economics students in North Carolina towards the teaching method used. A quasi experimental design was used to compare cooperative and non-cooperative (competitive) classroom structure. Results of the study showed no significant difference among the dependent variables (achievement and retention) and the teaching method used.

A study by Kwon Allen and Rasmussen (2005) aimed at investigating students' retention of mathematical knowledge and skills in two differential equation classes. Posttest and delayed Posttest after one year were administered to students in inquiry-oriented class, when compared with those in traditional classes. The results showed that the students in the inquiry-oriented class, when compared with those in the traditionally taught class retained conceptual knowledge as manifested by their performance on modelling problems better than those in the traditionally taught class. The result adds additional support to the claim that teaching for conceptual understanding can lead to longer retention of mathematical knowledge.

In a study that included retention treatments, Ikedolapo and Adetunji (2009) compared the relative effectiveness of the guided discovery and concept mapping teaching strategies in relation to students' performance in chemistry. The study sample comprised a total of 300 SSS chemistry students who had registered for Senior Secondary School Certificate Examination (SSCE) from four secondary schools in Bauchi Local Government Council of Nigeria. The t-test statistics was used to analyse the data obtained and the results indicated that there was no significant difference in the mean scores of the students due to post posttest (retention) treatments. It was also observed that gender made no significant difference when the mean scores of the method adopted were compared on the post posttest (retention) treatments.

They concluded by stating that the outcome implies that both methods were equally powerful in terms of improving students' performance in chemistry.

A non-equivalent quasi experimental study to determine the effectiveness of Ethnomathematics Teaching Approach (ETA) on students' achievement and retention in locus was carried out by Achor, Imoko and Uloko (2009), results from 2-Way analysis of covariance (ANCOVA) reportedly revealed that students exposed to ETA were superior in achievement and retention than those taught with conventional approach. The aforementioned studies have shown that the instructional strategy employed in teaching concepts to students has effects on both the achievement and retention ability of subjects. These observations are significant and this study therefore investigated the effect of age grouping on the retention ability of students at NOUN taught chemistry using the eLearning instructional strategy.

Rapid changes in Information and Communication Technologies (ICTs) have been a hallmark of the 21st century and this has been effectively put to use in education. E-learning is novel and is accorded various interpretations by many scholars, (Sales, 2002). It is qualified by some as digital learning, computer enhanced learning, and computer aided learning or online learning among others. Sales (2002) defined eLearning as the use of electronic technology to deliver education and training applications, monitor learner performance and report learner progress. E-Learning according to (Ogunleye, Oke and Adeoye, 2007) is the delivery of content via all electronic media, including the internet, intranets, Extranets, Satellite broadcast, audio/video tape, interactive television (TV) and CD - ROM.

A Learning Management System (LMS) is usually selected and populated with content, examples include, A-Tutor, Web CT and MOODLE to mention but a few. These LMS usually have salient interactive and performance monitoring features inbuilt. According to Sale (2002) the ability to do the stated makes eLearning an exceptionally appealing training mode. Software's used for developing eLearning platforms avails the learner the opportunity of accessing the contents and also monitor learner's performance generally of specifically such as when a learner finishes the training, how long it took the learner to finish, number of correct responses made by the learner and the percentage of correct responses made in association with

specific learning objectives. With this system, the learner can post queries, which can be responded to either instantly or subsequently. The learner can also return repeatedly, to any concept that may not have been fully understood from earlier hits and this may augur well for a better understanding of scientific facts and principles learnt. Basically, the learner is usually separated from the tutor or instructor in space and or time, uses some form of technology (usually a computer) to access the learning material and interact with the tutor or instructor or other learners. E-learning is thus not only about training and instruction but also about flexible and interactive learning that is tailored towards an individual's need. In summary therefore, eLearning refers to the use of Information and communication Technology (ICT) to enhance and support learning in tertiary education (OECD, 2005).

### **Research Question**

The study set out to answer the following research question: What are the effects of age on retention ability of chemistry students exposed to e- Learning instruction in Inorganic chemistry?

### **Hypothesis**

Based on the stated research question, the following null hypothesis was formulated for testing at  $<0.05$  levels of significance.

**H<sub>0</sub>:** There is no significant difference in the retention ability of chemistry students of different age groups, exposed to the e-Learning instruction.

### **Significance of the Study**

The outcome of this study will be of importance to the facilitators and planners of the teaching of chemistry courses at NOUN as they will be better positioned/informed on the effect of age on retention of concepts taught to the diverse age groups in the institution through the usage of eLearning platforms. Universities and tertiary institutions as well as fellow researchers would be able to identify what aspects to direct further energy on in the form of new researches, in relation to this study. Parents, stakeholders in the education sector such as authors, curriculum planners and administrators in general and science teachers in particular would have a better understanding of their roles in the provision of effective science teaching using current trends as available through various eLearning platforms in teaching/learning situations.

Open and distance education particularly at the tertiary level is fairly new to Nigeria, equally new is the usage of eLearning platforms for teaching and learning. The findings of the study would be useful in developing eLearning programmes for several topics in chemistry. It would also serve as a milestone, since not many studies have been carried out on the effects age and learning in a technologically mediated learning environment especially in an ODL setup.

Most research in the past had focused on performance of students in chemistry, therefore any study with emphasis on retention ability and age grouping would be of paramount importance to the education sector. The outcome is expected to serve as bedrock for further investigations on how to improve the teaching/learning procedure of the Open University system.

### **Scope of the Study**

This study was conducted on chemistry students at the Lagos study centre of the over sixty study centres of the National Open University of Nigeria. The Lagos study centre was selected because it has the highest number of 100 level chemistry students and furthermore, eLearning facilities are already available at the centre.

The concepts used for the study were selected from the 100 level Introductory Inorganic Chemistry (CHM 111) course material and are; Atomic Radii, Ionisation energy, Electron Affinity and Electronegativity. These concepts were selected because over time, the course CHM111 has been one of the chemistry courses in which NOUN students had been performing below expectation and moreover, it was available in the electronic form and could as such be readily deployed on to the eLearning Learning Management System. The study material used for teaching the topics was the study material developed by the National Open University of Nigeria.

### **Research Design**

The One-group Pre-test, Post-test, Post-Post-test pre-experimental research design with no control group as proposed by Kerlinger and Lee (2000), and was adopted for this study. The design of the study is illustrated in Figure 1.

$$SG \rightleftharpoons O_1 \rightleftharpoons X_1 \rightleftharpoons O_2 \rightleftharpoons O_3$$

Where:

- SG Study Group
- O<sub>1</sub> Pretest
- O<sub>2</sub> Posttest
- O<sub>3</sub> Post Posttest
- X<sub>1</sub> Treatment (e-Learning)

### Population of the Study

The population for the study comprised of a total of 453 undergraduate chemistry students offering CHM 111 (Introductory Inorganic Chemistry) registered for the 2010-2011 session at the National Open University of Nigeria (NOUN).

### Sample and Sampling Technique

The sample for this study comprised undergraduate chemistry students from the Lagos study centre of NOUN. The sampling technique used to select the centre is purposive, because the centre selected has the largest number of 100 level chemistry students.

A class consisting of 45 students in Lagos was used and the study subjects were all the 100 level chemistry students and involved intact classes. The study participants in Lagos were purposively selected as the experimental group because e-Learning facilities are already available at the centre. The subjects were classified into three age groups, which are: the younger age group comprising subjects in an age range less or equal to 29, the middle age group comprising of subjects with an age range of 30 - 49 and the advanced age group who are aged 50 or above. This is to facilitate the interpretation of the pattern of relationship that may manifest as a result of age group difference. This grouping was adopted from a classification used by McDonald and Stuart-Hamilton (1996), Sambo (2005) and Owens (2011). Table 1 shows the distribution of the subjects by age.

<b>Table 1: Distribution of Experimental Group by Age</b>	
<b>Age Group</b>	<b>No. Of Students</b>
Younger: — 29	4
Middle: 30-49	39
Advanced: 50+	2
<b>Total</b>	<b>45</b>

*Source: Field Work*

### **Instrumentation**

The instrument used for this study is a Chemistry Achievement Test (CAT). This was deployed onto a Learning Management System (LMS) known as Moodle.

### **Chemistry Achievement Test (CAT)**

The Chemistry Achievement Test (CAT) consists of a set of forty (40) multiple choice items designed to test the level of students understanding of the selected concepts in chemistry. The forty (40) multiple choice items consist of four response options, one of which is the correct answer while the remaining three serve as distractors. The test items were in conformity with Bloom's (1986) taxonomy of educational objectives in the cognitive domain, i.e. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. CAT was used as a pretest and posttest on the study group to compare the groups for significant differences if any, after the treatment. CAT was then used as a post posttest to determine the level of retention of concepts taught in chemistry.

### **Validity of the Chemistry Achievement Test (CAT)**

A team of experts in test and measurement and chemistry educators were used to carry out the validation of the instrument for the study. The experts chosen for the validation exercise comprised of four science educators with PhD qualifications and a minimum rank of senior lecturer.

### **Reliability of the Chemistry Achievement Test**

The test-retest method using the Pearson Product Moment Correlation Coefficient statistic was used to determine the reliability of the Chemistry Achievement Test (CAT) for this study. The same test was administered on two different occasions at two-week intervals as recommended by Tuckman (1975). The reliability coefficient of CAT after correlation was 0.78, showing that the instrument is reliable and was used for data collection in this study.

### **Administration of Treatment**

A study centre of the National Open University of Nigeria was used for the study. This was the Lagos study centre. Students of the Lagos study centre were administered with assessment procedures from CAT. The Chemistry Achievement Test (CAT) consists of a set of forty (40) multiple choice items

designed to test the level of students understanding of the selected concepts in chemistry. The forty (40) multiple choice items consist of four response options, one of which is the correct answer while the remaining three serve as distractors. The test items are in conformity with Bloom's (1986) taxonomy of educational objectives in the cognitive domain, i.e Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. CAT was used as a pre-test to determine the equivalence of the age groups and as post-test to compare the groups for significant differences if any, after the treatment. CAT was also then used as a post-test to determine the level of retention of concepts taught in Inorganic Chemistry.

CAT was administered on the subjects under the supervision of the researcher and research assistant. The assessment protocol was a computer-based test which was populated onto a Learning Management System known as MOODLE. The subjects were allowed a total of forty minutes to participate in the test before being logged off, correct responses were awarded one mark while any wrong response attracted a zero mark and the total obtainable mark was 40.

**Table 2: Specification of Items as used in the Study**

Concept	Item	Total
Atomic Radii	24,25,26,27,28,30,31,32,33	10
Ionisation Energy	1,2,7,8,10,18,19,20,34,35	10
Electron Affinity	3,11,12,13,21,22,23,38,39,40	10
Electronegativity	4,5,6,9,14,15,16,17,36,37	10

### **Data Collection Procedure**

Data for this study was collected with the aid of a Chemistry Achievement Test (CAT). CAT was administered as pretest and posttest then after two weeks, a post posttest was administered using CAT to test for the retention ability of the subject. The assessment protocol was a Computer Based test which was populated onto a Learning Management System known as

## MOODLE

### Data Analysis and Presentation of Results

**Research Question:** What are the effects of age on retention ability of chemistry students exposed to e-Learning instruction in Inorganic chemistry? The data collected for the purpose of answering this research question was analysed using descriptive statistics in the form of Means and Standard Deviation (SD). To observe the difference in the pretest and posttest means scores of students of different age groups exposed to the e-Learning Instruction. The data collected was analysed using means and standard deviation and the result is presented in Table 3.

**Table 3: Mean and Standard Deviation Scores of Pretest/Posttest in CAT of Subjects of Different Age Groups**

Age Groups	N	Mean	SD
Younger	4	56.75	8.88
Middle	39	47.79	8.05
Advanced	2	44.50	6.36

In Table 3, the result revealed that there was difference in the mean scores of the groups after pretest, posttest. Similarly, the data collected was analysed as follows to observe if there was any difference in Post-Posttest mean scores of the various are groups.

**Table 4: Mean Retention Scores and Standard Deviation in CAT Pretest-Posttest of Subjects of Different Age Groups**

Age Groups	N	Mean	SD
Younger	4	4.25	2.22
Middle	39	3.64	2.06
Advanced	2	3.50	0.71

Table 4 reveals that there is a difference in the mean scores of the groups. To test whether there is a significant difference in the mean scores of the groups as stated in  $H_0$  as follows:

**Hypothesis ( $H_0$ ):** There is no significant difference in the retention ability of chemistry students of different age groups, exposed to the e-Learning instructional strategy. One Way Analysis of Variance (One Way ANOVA) was used to find out if there as a different age groups taught using the eLearning instructional strategy. Rejection or retention of the null hypothesis was set at  $p \leq 0.05$  level of significance.

Table 5: Results of One Way Analysis of Variance of the Post-Posttest Means Retention Scores in CAT of Subjects of Different Age Groups.

Source of variance	Sum of squares	Df	Mean Square	F	Sig.	Remark
<b>Between Groups</b>	1.42	2	0.71			
				0.16	0.84	NS
<b>Within Groups</b>	176.22	42	4.19			
<b>Total</b>	177.64	44				

Significant  $\leq 0.05$

In Table 5, the result reveals that the observed value for p (0.84) is greater than  $P = 0.05$  at  $df = 2$  and  $42$  and  $F = 0.16$ . This implies that there is no significant difference in the retention ability of chemistry students of different age groups. The null hypothesis, which stated that there is no significant difference in the retention ability of chemistry students of different age groups, taught using the e-Learning instrument strategy is thus not rejected

## **Summary of Findings**

The following are the major findings after the analysis of data collected for this study. There is no significant difference in the retention ability of chemistry students of different age groups, taught using the e-Learning instructional strategy at the National Open University of Nigeria.

## **Discussion**

There is no significant difference in the retention ability of the subjects of the study, irrespective of age grouping. This is a contrary position to those held by (McDonald & Stuart Hamilton, 1996; Jande, 1998; Kanwar, 2008 and Muwange - Zake, 2008). They had informed that Africans are likely to find computers in adulthood and as such, older people are less inclined to ICT, which incidentally is the bedrock of eLearning. Kanwar (2008) had described the youths of his generation as 'digital natives', who are born into technology and find it easier to comprehend and operate the ICT tools of nowadays, in comparison to the older people who are designated as 'digital migrants'. They on the other hand have to learn to manipulate these tools of ICT and most at times have difficulties comprehending and fully manipulating these gadgets she had further asserted.

Literature on past studies relating to eLearning, age grouping and retention ability of students are difficult to come by but the results of the study buttresses some other views held about eLearning and some other variables. A study by Ikedolapo and Adetunji (2009) on retention ability of concepts and gender revealed that there was no significant difference in the mean scores of the subject due to post posttest (retention) treatment. Another study that established that there was no significant difference between the retention ability of students was that by Abu and Flowers (1997), this was on academic achievement as it relates to retention ability. A study by Kwon Allen and Rasmussen (2005) had investigated students' retention of mathematical knowledge and skills in two differential equation classes in inquiry-oriented and traditional classes. The results showed that the students in the inquiry- oriented classes retained conceptual knowledge better when compared with those in the traditionally taught classes. The result adds additional support to the claim that teaching for conceptual understanding can lead to longer retention of mathematical knowledge. It seems beneficial for faculty in the higher educational setting to be aware of differences between the older learner and the traditional college age student.

## **Conclusion**

Within the limits of the findings of this investigation, the following conclusions are made: that retention ability of chemistry students taught using the eLearning instructional strategy does not depend on the age of the subjects.

## **Implication of the Findings for Science Education**

The outcome of this study has shown that age of participants has no significant effect on the retention ability of concepts in chemistry by students of NOUN, exposed to the eLearning instructional strategy. With the eLearning instructional strategy, students use electronic technology to navigate through a series of activities designed to move learners through structured series of experiences e.g. lessons, with the goal of achieving specific learning outcomes. The implication of this is that the availability of a technologically mediated teaching environment can add additional support to teaching for conceptual understanding. This can lead to a longer retention of concepts taught and similarly augur well for improved academic achievement in science subjects by students irrespective of age, thus making it an appealing tool for instruction in ODL institutions.

## **Recommendations**

Based on the findings of this study, the following recommendations are made: since it has been established that with a technologically mediated learning environment as provided by the eLearning platform, age is not a hindrance, facilitators and planners of the teaching of chemistry courses at NOUN and ODL institutions should be made aware. Efforts should be made at entrenching the instructional mode at NOUN, Distance Learning Institutes tertiary institutions and ODL establishments in the country. This can be achieved via massive eEducation campaigns and funding/deployment of ICT tools to relevant quarters by government and agencies. Finally, it is recommended that students and teachers should be constantly trained and retrained on the usage of ICT tools in/for education.

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