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EFFECT OF MULTIMEDIA INSTRUCTION AND EXPERIENTIAL LEARNING STRATEGY ON STUDENTS' RETENTION OF GAS LAWS IN OBIO-AKPOR LOCAL GOVERNMENT AREA, RIVERS STATE

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Abstract
This study investigated the effect of Multimedia Instruction and Experiential Learning Strategy on students' retention of the concept of Gas Laws in Senior Secondary Schools in Obio-Akpor Local Government Area, Rivers State. This study adopted a quasi-experimental pre-test, post-test, and non-equivalent group design. Three objectives, three research questions and three null hypotheses guided this study. One hundred and fifty-four (154) SS2 students drawn from three intact classes in three public Senior Secondary Schools in Obio-Akpor Local Government Area constituted the sample for the study. The instruments for data collection were validated researcher-constructed tests titled 'Chemistry Performance Test' and 'Chemistry Retention Test'. Reliability coefficients of 0.85 and 0.80 respectively were obtained for the instruments using the Kuder-Richardson-21 formula. Mean, standard deviation and percentage were used to answer the research questions while the hypotheses were tested using Analysis of Covariance. The result showed that there is a significant difference among students exposed to Multimedia Instruction, Experiential learning Strategy and Discussion method in their retention of the Gas Laws concept at comprehension and application levels of Bloom's Taxonomy. Multimedia Instruction and Experiential Learning Strategy enhanced retention more than the Discussion method. The findings further showed that male students retained more than female students at both comprehension and application levels. Multimedia Instruction and Experiential Learning Strategies are therefore recommended for the teaching of scientific concepts such as Gas Laws.

Keywords: Multimedia instruction, Experiential learning strategy, Retention, Gas Laws, Comprehension level, Application level

Introduction

Chemistry is an important science subject. The study of Chemistry is aimed at understanding the composition and properties of matter, as well as explaining the reason for the changes experienced by matter and how the changes occur. Also, in the study of Chemistry, process skills which include observing, measuring, inferring, predicting, communicating, and critical thinking are acquired. Nnoli and Christopher (2017) affirm that Chemistry is a practical subject and its application result in the acquisition of various scientific skills. There is an element of Chemistry in everything done by man. The universe is made of matter. It is an essential science subject whose knowledge is needed for sustenance and everyday living. Technologies based on the knowledge of Chemistry have provided solutions to societal problems and enriched the quality of life in every sector such as energy usage and health. Enedoh (2017) noted that Chemistry is the life we live so teachers should be able to teach it in a way that students can relate it to their immediate environment. Chemistry should not be taught as an abstract subject because they are about things found in the environment.

Retention is the ability of a learner to remember or reproduce what was learned after some time. It involves mentally storing information and the ability to recall or retrieve the information stored over time. Retention is seen through perception, a conscious effort, accountability, exercise, routines, and colours among others. It is an

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important variable in learning because students will perform high in scientific concepts and apply their knowledge in real-life situations only if they can retain what was learned. Sensory memory also known as 'working' memory is the information that passes quickly from the senses to the brain. The information moves into short-term memory if attention is given to it. If more focus is given to the information, it moves into long-term memory where it is stored for some time or life. Many factors however can determine if the information will be moved into long-term memory or not. The factors include if the information is related to other information in the memory, how the information is attached to some emotions, circumstances, or situations around the acquisition of the information, rote memorization, etc.

Memory stores information accurately and enables optimum decision-making in chaotic or challenging situations (Richards & Frankland, 2017). Meanwhile, forgetting is a process that evaluates and discards any information which does not promote survival. When a piece of new knowledge is presented to the students, they try to connect it to existing information in their memory. Duncan (2010) in Eze (2016) submitted that poor learning and retention in social science and arts could be related to the inability to link new learning to previous knowledge of the learner. Students will be able to retain new knowledge when the new knowledge is taught in such a way that it is connected to other concepts. The new knowledge is retained also if the students repeatedly access the memory over time. Information is easily forgotten if the learner is not eager to learn or accept the new information. It can also occur due to a lack of concentration by the learner which leads to encoding failure in which the new information never made it to the learner's memory. Information can also be easily forgotten when the new information is not connected to a sense or feeling in the learner hence shallow processing of the information occurs. Furthermore, older information is easily forgotten when a new one is provided on the same subject. This is referred to as retroactive interference. The inability to regularly go over previously learned knowledge because it is not regularly needed can also make a learner forget the knowledge.

Some of the instructional strategies used in teaching scientific concepts can lead to rote memorization which results in a superficial grasp of the concepts, and the knowledge of the concept is quickly forgotten. Oka et al. (2010) reported poor teaching methods as one of the factors affecting students' retention of concepts in social science and arts courses. Asongu and Nwachukwu (2017) similarly noted that learners resort to memorization when they do not understand the concepts, emphasizing that learners can only learn and retain the knowledge when teachers use instructional strategies that can enable learners to link new knowledge to previously learned one. There is therefore a need for instructional strategies that can enhance the ability of learners to retain the knowledge of scientific concepts. In multimedia instruction, knowledge or content is presented in pictures and words other than words only. The words may be spoken or printed while pictures may be static (charts, photos, graphs, illustrations, etc.) or dynamic (video or animation). Multimedia instruction can be in form of video games, virtual environments, slide shows, e-learning, books, etc. It can enable deep learning and retention of knowledge. Experiential learning is a learning process in which students are provided with an engaging hands-on experience such as practical work, laboratory work, and fieldwork. The students are made to learn by doing through experience as they perform experiments, explore, and discover knowledge. According to Raudys (2018), activities involved in experiential learning encourage and motivate students to learn, and in turn enhance the retention of knowledge. The discussion method involves an open-ended interaction in which students exchange ideas with one another or with the teacher. The discussion method enables learning, critical thinking, problem-solving, and literary appreciation (Yale, 2021). In the discussion method which may be led by the teacher or a student among a small group or a whole class, students present different views and ideas on the concept at hand, reflect on the ideas, and thereafter respond. This enables the students to correct their misconceptions, understand the concept and construct their knowledge.

Literature is replete with instructional strategies which have been found to enhance students' retention of scientific concepts. Ajayi and Angura (2017) discovered a significant difference in the mean retention scores between students taught electrolysis using Collaborative Concept Mapping Instructional Strategy (CCMIS) and discussion method, in favour of CCMIS. Ndioho and Walele (2017) discovered that the Gallery walk teaching strategy enhanced the retention of Basic Science concepts more than the Lecture method. Nwobasi and Nwani (2020) discovered that Videotape instructional package significantly improved students' retention of Chemistry concepts than the traditional method. Obafemi and Macaulay (2022) discovered a significant difference between

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the retention ability of students taught electrolysis using the Simulation Instructional strategy and those taught using Teacher-demonstration, in favour of the Simulation Instructional strategy. Umar et al. (2015) found that multimedia instruction enabled better retention in auto-mechanics than the conventional method. Eze et al.(2020) similarly reported that multimedia technology improved students' ability to retain knowledge. Bada and Akinbobola (2020) reported that the Experiential learning strategy enhanced students' retention.

Ekenobi et al. (2016) found that gender did not significantly influence students' retention of the redox reaction concept. Ajayi and Angura (2017) found no significant difference between the mean retention scores of male and female students in electrolysis. Ndioho and Walele (2017) discovered that gender had no significant effect on students' retention of Basic science concepts. Okeke (2018) found that gender did not influence students' retention of the Chemistry concept. Ibeneme and Akinlabi (2021) similarly found no significant difference between the retention ability of male and female students. Owodunni and Ogundola (2013) however reported that the mean score of female students was higher than that of male students in the test for retention of learning. Obafemi and Macaulay (2022) similarly discovered that female students retained the knowledge of the Electrolysis concept better than male students though the difference was not significant. There is a paucity of literature on retention at higher levels of Bloom's taxonomy, hence the focus on retention at higher levels of comprehension and application in this study.

According to the report of the West African Examination Council (WAEC) Chief examiners for 2016, 2018 and 2019, the inability to correctly answer questions on core concepts such as Gas Laws contributed to the failure of students in Chemistry. This is worrisome because even though the concept of Gas Laws is taught not only in Chemistry but also in Physics, students still find it difficult. What could be the reason for the seemingly difficult nature of the concept of Gas Laws? Could it be due to the ineffective nature of the strategy being used in teaching the concept? This study, therefore, intends to find out the effect of Multimedia Instruction and Experiential Learning Strategy on students' retention of the concept of Gas laws at comprehension and application levels in Senior Secondary Schools in Obio-Akpor Local Government Area, Rivers State.

Aim and Objectives of the Study

This study aimed to investigate the effects of Multimedia Instruction and Experiential Learning Strategy on students' retention of the concept of Gas laws in Senior Secondary Schools in Obio-Akpor Local Government Area, Rivers State.

The objectives of the study are to:

1) determine the effect of instructional strategy on students' retention of the concept of Gas laws at comprehension and application levels.
2) determine the influence of gender on students' retention of the concept of Gas laws at comprehension and application levels.

Research Questions

The following questions guided the study:

1) What is the effect of instructional strategy on students' retention of the concept of Gas laws at comprehension and application levels?
2) What is the influence of gender on students' retention of the concept of Gas laws at comprehension and application levels?

Hypotheses

The following three null hypotheses were tested at a 0.05 level of significance:

1. There is no significant difference among students taught using different instructional strategies (Multimedia Instruction, Experiential Learning Strategy and Discussion method) in their retention of the concept of Gas laws at comprehension and application levels.
2. No significant difference exists between male and female students in their retention of the concept of Gas laws at comprehension and application levels.

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Materials and Methods

The design for this study is the quasi-experimental pre-test, post-test, non-equivalent group design. The population of the study comprised 5,587 Senior Secondary 2 (SS2) students (made up of 3037 females and 2550 males) from public senior secondary schools in Obio-Akpor Local Government Area of Rivers State. Multistage sampling technique (stratified random sampling and simple random sampling) was used to select a sample of one hundred and fifty-four (154) SS2 students from three intact classes in three public Senior Secondary Schools for this study. Two intact classes were experimental groups while the third class was the control group. The instruments for data collection were two tests titled 'Chemistry Performance Test' (CPT) and 'Chemistry Retention Test' (CRT).

The instrument CPT was developed by the researcher to test the performance of students in Gas Laws while CRT was a reshuffled version of CPT intended to measure students' retention of the concept of Gas laws. These instruments were based on the topics (Boyles' Law, Charles' Law and Ideal Gas Law). Each of the instruments consists of 40 multiple-choice questions which covered comprehension and application levels of Bloom's taxonomy. The multiple choice objective test items had options A, B, C and D and 2.50 marks were assigned to each correct answer while the wrong answer attracts a zero (0) score. The maximum score for the items was 100 marks. The instruments for data collection CPT and CRT were validated by two Science Education experts, one Chemistry teacher, and two experts in Measurement and Evaluation at the University of Port Harcourt to ascertain the face, content, and construct validity of the instrument. Their inputs and corrections were reflected in the final draft of the instruments. The trial testing of the instruments was done by administering copies of the instruments to forty (40) SS2 Chemistry students from an intact class in a school that had the same background and characteristics as the sampled schools but was not part of the study. Reliability coefficients of 0.85 and 0.80 respectively were obtained for the instruments using the Kuder-Richardson-21 formula. CPT was administered as a pre-test to both the experimental and control groups before each of the groups was taught Gas Laws (Boyles' Law, Charles' Law and Ideal Gas Law) lasting four weeks. The first experimental group was taught using Multimedia Instruction, the second experimental group was taught using the Experiential learning strategy, and the control group was taught using the Discussion method. At the end of the teaching, CPT was administered as a post-test to both experimental and control groups. Two weeks after the administration of the post-test, CRT was administered to the students as a post-post-test. The student responses to the instruments constituted the data for the study. Mean, standard deviation and percentage were used to answer the research questions while Analysis of Covariance was used to test the hypotheses at a 0.05 level of significance.

Results

Research Question 1: What is the effect of instructional strategy on students' retention of the concept of Gas laws at comprehension and application levels?

Table 1: Mean scores of students' retention at comprehension and application levels classified by instructional strategy.

			Post-test		Post-post-test			
	Strategies	**n**	**Mean**	**Sd**	**Mean**	**Sd**	**Mean Gain**	**Mean Gain%**
Comprehension Level	Multimedia	39	16.95	2.01	17.21	1.85	0.26	1.53
	Experiential	67	13.6	2.36	14.73	1.94	1.13	8.31
	Discussion	48	11.81	2.5	10.56	3.89	-1.25	-10.58
Application Level	Multimedia	39	11.39	2.93	14	2.42	2.62	23.02
	Experiential	67	9.39	2.26	13.18	2.95	3.79	40.36
	Discussion	48	7.65	2.54	9.4	2.63	1.75	22.88

Table 1 shows that at the Comprehension level, the students taught using the Experiential learning strategy had the highest retention percentage mean gain of 8.31, followed by students taught using Multimedia instruction

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with a percentage mean gain of 1.53 while the students taught using the Discussion method had the least percentage mean gain of -10.58. Table 1 further shows that at the Application level, the students taught using the Experiential learning strategy had the highest retention percentage mean gain of 40.36, followed by students taught using Multimedia instruction with a percentage mean gain of 23.02 while the students taught using the Discussion method had the least percentage mean gain of 22.88. These results indicate that at Comprehension and Application levels, students taught using the Experiential learning strategy retained most, followed by the students taught using Multimedia instruction and then students taught using the Discussion method.

Research Question 2: What is the influence of gender on students' retention of the concept of Gas laws at comprehension and application levels?

Table 2: Mean scores of students' retention at comprehension and application levels classified by gender.

			Posttest		Post-post-test			
	Gender	**n**	**Mean**	**Sd**	**Mean**	**Sd**	**Mean Gain**	**Mean Gain%**
Comprehension Level	Male	87	14.09	3.16	14.39	3.76	0.3	2.13
	Female	67	13.63	2.84	13.76	3.6	0.13	0.95
Application Level								
	Male	87	9.49	2.87	12.44	3.33	2.95	31.09
	Female	67	9.16	2.89	11.91	3.32	2.75	30.02

Table 2 shows that at the Comprehension level, male students had a retention percentage mean gain of 2.13, while female students had a retention percentage mean gain of 0.95. Table 2 further shows that at the Application level, male students had a retention percentage mean gain of 31.09, while female students had a retention percentage mean gain of 30.02. These results indicate that at Comprehension and Application levels, male students retained more of the concept of Gas laws than their female counterparts.

Hypothesis 1: There is no significant difference among students taught using different instructional strategies (Multimedia Instruction, Experiential Learning Strategy, and Discussion method) in their retention of the concept of Gas laws at comprehension and application levels.

Table 3: Summary of Analysis of Covariance of the effect of strategy on retention at comprehension and application levels using post-test as a covariate. Comprehension Level

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Comprehension level					
Corrected Model	1149.215[a]	3	383.072	60.917	0.000
Intercept	272.459	1	272.459	43.327	0.000
Posttest_comprehension	146.076	1	146.076	23.230	0.000
Strategy	351.459	2	175.729	27.945	0.000
Error	943.259	150	6.288		
Total	32529.000	154			
Corrected Total	2092.474	153			

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Application Level

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	575.705[a]	3	191.902	25.755	0.000
Intercept	1288.643	1	1288.643	172.950	0.000
Posttest_Application	7.684	1	7.684	1.031	0.311
Strategy	407.874	2	203.937	27.370	0.000
Error	1117.646	150	7.451		
Total	24644.000	154			
Corrected Total	1693.351	153			

At the comprehension level, Table 3 shows an F value of $F_{2,150} = 27.945$, $p = 0.000$ ($p < 0.05$), indicating a significant effect of strategy on retention. Similarly, at the application level, Table 3 shows an F value of $F_{2,150} = 27.370$, $p = 0.000$ ($p < 0.05$), also indicating a significant effect of strategy on retention. The null hypothesis is thus rejected. In other words, there is a significant difference among students taught using different instructional strategies in their retention of the concept of Gas laws at comprehension and application levels.

Table 4: Post hoc analysis of students' retention at comprehension and application levels.

Comprehension level (I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% CI	
					LB	UB
Discussion Method	Experiential Method	-4.1688*	0.50791	0.00	-5.4245	-2.9132
	Multimedia Method	-6.6426*	0.57903	0.00	-8.0741	-5.2111
Experiential Method	Discussion Method	4.1688*	0.50791	0.00	2.9132	5.4245
	Multimedia Method	-2.4738*	0.54097	0.00	-3.8112	-1.1364
Multimedia Method	Discussion Method	6.6426*	0.57903	0.00	5.2111	8.0741
	Experiential Method	2.4738*	0.54097	0.00	1.1364	3.8112
Application level						
(I) Groups	**(J) Groups**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% CI**	
					LB	**UB**
Discussion Method	Experiential Method	-3.7833*	0.51623	0.00	-5.0595	-2.507
	Multimedia Method	-4.6042*	0.58852	0.00	-6.0591	-3.1492
Experiential Method	Discussion Method	3.7833*	0.51623	0.00	2.5070	5.0595
	Multimedia Method	-0.8209	0.54984	0.33	-2.1802	0.5384
Multimedia Method	Discussion Method	4.6042*	0.58852	0.00	3.1492	6.0591
	Experiential Method	0.8209	0.54984	0.33	-0.5384	2.1802

*** The mean difference is significant at the 0.05 level**

The post hoc analysis presented in Table 4 reveals that at both comprehension and application levels, Multimedia instruction contributed most to the significant difference in the effect of the strategies on students' retention of the concept of Gas laws.

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Hypothesis 2: There is no significant difference between male and female students in their retention of the concept of Gas laws at comprehension and application levels.

Table 5: Summary of Analysis of Covariance of Retention of male and female students using post-test as a covariate

Comprehension Level

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	804.258[a]	2	402.129	47.136	0.000
Intercept	91.35	1	91.35	10.708	0.001
Posttest_comprehension	782.168	1	782.168	91.683	0.000
Gender	6.502	1	6.502	0.762	0.384
Error	1288.216	151	8.531		
Total	32529	154			
Corrected Total	2092.474	153			

Application Level

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	174.094[a]	2	87.047	8.652	0.000
Intercept	1027.017	1	1027.017	102.076	0.000
Posttest_Application	163.609	1	163.609	16.261	0.000
Gender	6.263	1	6.263	0.622	0.431
Error	1519.256	151	10.061		
Total	24644	154			
Corrected Total	1693.351	153			

At the comprehension level, Table 5 shows an F value of $F_{1,151} = 0.762$, $p = 0.384$ ($p > 0.05$), indicating no significant effect of gender on retention. Similarly, at the application level, Table 5 shows an F value of $F_{1,151} = 0.622$, $p = 0.431$ ($p > 0.05$), also indicating no significant effect of gender on retention. The null hypothesis is thus retained. In other words, there is no significant difference between male and female students in their retention of the concept of Gas laws at comprehension and application levels.

Discussion

The findings of this study revealed that at Comprehension and Application levels, students taught using the Experiential learning strategy retained the most, followed by the students taught using Multimedia instruction and then, the students taught using the Discussion method. There is a significant difference among students exposed to different instructional strategies in their retention of the concept of Gas laws at comprehension and application levels. Multimedia instruction contributed most to the significant difference in the effect of the strategies on students' retention of the concept of Gas laws at both levels, followed by the effect of the Experiential learning strategy. These findings indicate that both Multimedia instruction and Experiential learning strategies enhance students' retention of knowledge more than the Discussion method. The findings may be due to the participatory and engaging nature of Multimedia instruction and Experiential learning strategy. The findings are in agreement with the findings of Umar et al. (2015) and Eze et al. (2020) who found that multimedia instruction is more effective in improving students' retention. The findings also agree with the findings of Bada and Akinbobola (2020) who reported that experiential learning strategy enhanced the retention of knowledge.

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The findings of this study further revealed that at comprehension and application levels, male students retained more of the concept of Gas laws than their female counterparts. This is at variance with the finding of Owodunni and Ogundola (2013) and Obafemi and Macaulay (2022) that female students retained better than male students. This study also revealed that the difference in retention between male and female students was not significant. This finding agrees with the findings of Ekenobi et al.(2016), Ajayi and Angura (2017), Ndioho and Walele (2017), Okeke (2018) and Ibeneme and Akinlabi (2021) who found no significant difference between the retention ability of male and female students.

Conclusion

The study investigated the effect of Multimedia Instruction and Experiential Learning Strategy on students' retention of Chemistry in senior secondary schools in Obio-Akpor Local Government Area, Rivers State. The study looked at retention at two levels of Bloom's taxonomy which are comprehension and application levels. The study showed that Multimedia instruction and Experiential learning strategies enhance students' retention of knowledge more than the Discussion method. It also showed that male students retained better than female students at both comprehension level and application levels though the difference was not significant. Retention of the knowledge of scientific concepts is very crucial in science teaching and learning. Teachers need to embrace the teaching of scientific concepts beyond the lowest level of Bloom's taxonomy (knowledge level) to higher levels of comprehension and application as indicated in this study. This will enable the transfer of knowledge needed by students to live sustainably in society and tackle everyday life issues.

Recommendation

Multimedia Instruction and Experiential Learning Strategies are recommended for the teaching of seemingly difficult scientific concepts such as Gas laws.

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