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Enhancing Effective Chemistry Learning Through Hypermedia Instructional Mode of Delivery

Mutahir Oluwafemi Abanikannda *

Osun State University, NIGERIA

Abstract: This study provides a framework for the production of Hypermedia Instructional package. It also assessed the effectiveness of hypermedia instructional mode of delivery on students' performance in Chemistry. This is with a view of improving the learning of Chemistry which may eventually help to improve students' performance. The developmental study employed a pre-test, post-test control group design. The research sample consisted of 60 private secondary school students in Osun State with an enrolment of 30 students from each of the two schools selected. The students were thereafter assigned to experimental and control groups. The stimulus material used for the experimental group was the Hypermedia Instructional Package, while the Control group received instruction with similar content through the conventional method. The test instrument used was Hypermedia Learning Achievement Test (HLAT). Content and face validity of the instrument used was carried out by experts in the area of tests and measurement. The Cronbach's alpha reliability coefficient for the HLAT gave a value of 0.72. Data collected were analyzed using descriptive and inferential statistics. Results obtained showed that students exposed to the Hypermedia Instructional Package (HIP) performed significantly better than those exposed to the conventional teaching method ($t = 5.458$, $df = 58$, $p < 0.05$). Results also revealed a significant difference in the retention ability of students in Chemistry between those exposed to the package and those that were not ($t = 6.842$, $df = 58$, $p < 0.05$). The study concluded that the use of HIP was an intervention which improved students' performance retention and attitude towards Chemistry.

Keywords: *Hypermedia instructional package, hypermedia learning achievement test, retention ability.*

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Introduction

Science is a significant component of human society. Its influence on cultural, socio-economic, political, technological and even religious activities is fundamental to the extent that one could safely say that the present ways of life would be impossible without science. The value and significance of Science in modern day world can definitely not be over-emphasized, as the interaction of man with Science is definitely inevitable.

Science is generally defined as a body of knowledge, a way of investigation or method, and a way of thinking in the pursuit of understanding of nature (Abimbola & Omosewo, 2006). Science is a significant component of human society and its cultural, political, socio-economic and technological significance is so fundamental. Obianke (2009) reported that science continues to contribute to human life, especially in areas of medicine, shelter, leisure, communication, security, education, transportation and sports. In all nations of the world (Nigeria inclusive) science and mathematics are given first class attention due to

numerous benefits derived from them.

Nigeria has one of its set goals to be economical and technological advancement, and necessary measures need to be put in place to achieve this. This led to the formulation of the national policy on education (Federal Republic of Nigeria, 2014), which lays more emphasis on the teaching of science education and providing a strong foundation of science from the primary to the tertiary levels. Aluko (2004) states that the development of Nigerian secondary schools science project (NSSSP) which is an immense contribution to curriculum innovations in Science in Nigeria by Science Teachers' Association of Nigeria (STAN) and Comparative Education Study and Adaptation Centre (CESAC) is in recognition of the crucial role Science plays, in the development of any nation. The need for effective teaching and learning of science in secondary schools has been stated by the Federal Government of Nigeria, in its National policy on Education (Jegede, 2000).

Chemistry is the study of all matter and the changes

* Correspondence:

Mutahir Oluwafemi Abanikannda, Department of Science, Technology and Mathematics Education, Osun State University, Osun State, Nigeria.
E-mail: moabanix@gmail.com

that occur to all things, it is the study of the building blocks of all matter and the interactions between them. Chemistry takes that knowledge to see how matter is made up and changes in that matter (Davies, 2007). It is the science of matter, especially its chemical reactions, but also its composition, structure and properties. Chemistry is concerned with atoms and their interactions with other atoms, and particularly with the properties of chemical bonds. Jegede (2007) states that Chemistry occupies a central position among the science subjects and that it is a core subject for the medical sciences, textile technology, agricultural science, synthetic Industry, printing technology, pharmacy and chemical engineering, to mention just a few. Chemistry is sometimes called the central science because it connects Physics with other natural sciences such as Geology and Biology (Brown, Lemay, Bursten, 2005). Chemistry is a branch of physical science but distinct from Physics (Bunge, n.d.), Physics focuses on physical changes, forces and energy. Biology completes the field of science by looking at living things and the effects chemical and physical changes have on them (Davies, 2007).

For these reasons, Chemistry has been found to be indispensable in the school curriculum. However, these good features of modern Chemistry which are very essential for human development are eluding the present day learners, because of the difficulties they

experience in learning its content. According to Oloruntegbe and Odutuyi (2008) a student who is deficient in Chemistry, and has good grades in other science subjects will hardly be able to offer any course in the faculties of Science, Medicine and Engineering in the Universities. Chemistry which is believed to be the mother of science equips students with knowledge in areas such as drugs, diseases, pollution, food, chemicals etc which when applied to the society improves man standard of living. Despite the importance of Chemistry to our society, the choice and interest of students are influenced by several factors and variables among which gender and mathematics ability are major factors.

Chemistry over the years is no longer one of the most popular science subjects chosen by students and it is not among the subjects that students pass most as illustrated in Table 1. The table shows a considerably progressive increase in the enrolment of students in science subjects within the period of 2006 and 2014. It could however be observed that there is a fluctuating performance of students progressively within those years, and Chemistry is not left out. For instance, in 2006, only 49.90% of students who sat for Chemistry passed the subject at credit level, 33.94% of students who sat for Chemistry in the year 2008 passed the subject at credit level, only 50.70% of students who sat for Chemistry in 2010 passed at credit level, while

Table 1: Science Students Performance in WASSCE (May/June, 2006-2014) in Nigeria

Subject	Year of Examination	Total Sat	Total Credit Pass(A1-C6)%	Percentage (%)
B I O L O G Y	2006	1137181	59854	(49.24%)
	2007	1238163	413211	(33.37%)
	2008	1259965	427644	(33.94%)
	2009	1340206	383112	(28.59%)
	2010	1300418	427644	(33.90%)
	2011	1505199	579432	(38.50%)
	2012	1672224	649156	(38.81%)
	2013	1643389	696257	(42.38%)
C H E M I S T R Y	2014	1692435	791227	(46.75%)
	2006	380104	160670	(44.90%)
	2007	422681	194284	(45.96%)
	2008	418423	185949	(33.94%)
	2009	468546	204725	(43.69%)
	2010	465643	236059	(50.70%)
	2011	565692	280250	(49.54%)
	2012	632761	401966	(63.53%)
P H Y S I C S	2013	659265	396725	(60.18%)
	2014	688124	492111	(71.51%)
	2006	375824	218199	(58.05%)
	2007	418593	180797	(43.19%)
	2008	415113	200345	(48.26%)
	2009	465636	222722	(47.83%)
	2010	463755	237756	(51.30%)
	2011	563161	360096	(63.94%)
S C I E N C E	2012	627231	418412	(63.94%)
	2013	635374	438114	(68.95%)
	2014	676241	488154	(72.19%)

Source: WAEC (2014) Annual Report, Yaba Lagos

63.53% of those who sat for Chemistry passed at credit level in 2012, however, 71.51% of students who sat for Chemistry in 2014 passed at credit level. This of course is a manifestation of the inconsistency in the performance of science students.

A reasonable question worth asking is what could be responsible for secondary school students' waning interest and low level of performance in Chemistry. Researchers have adduced several reasons for this. Oloyede (2004) identified that one of the reasons for this low performance is the methods used by the teachers. The Chemistry concepts are volatile and their content largely dictated by the stereo-typed examination such as the West African School Certificate Examination (W.A.S.C.E); the National Examination Council (N.E.C.O.); and University Matriculation Examination (U.M.E.). This stifles rather than stimulate the Students interest.

Poor study habits and other factors which include physiological and psychological parameters in the living and learning environments of the student were identified by Alam, Oloruntegbe and Orimogunje (2010) as responsible for low performance of students in Chemistry. Gbore (2006) carried out a study to establish that study habit have strong relationship with academic performance of students. Chemistry is essentially a practical oriented subject which demands proper exhibition of good study behaviour for effective interpretation of existing phenomena (Njelita, 2008). Students are rarely exposed to practical work leading to failure.

Tafa (2012) observed that chemistry students face difficulty in understanding the importance of every laboratory activity in chemistry. The absence of these skills gave rise to students' poor performance in chemistry.

Notable among the problems of teaching and learning Chemistry in Nigerian secondary schools therefore include: insufficiency of trained and qualified Chemistry teachers; paucity of adequately equipped laboratories, and inadequacy of relevant instructional materials and devices that can help students study science on their own. There is no doubt that there is an urgent need to provide an alternative source of learning for the students. One of such alternatives is being offered by this study which mainly focuses on determining the effectiveness of hypermedia instructional mode of delivery on learning Chemistry in Nigeria secondary schools.

Objectives of the study

The objectives of the study are to

i. design and produce a hypermedia instructional package which allows users to access the information

according to their unique needs and interests in selected Chemistry topics;

ii. assess the effectiveness of the Hypermedia Instructional Package on students' performance in iii. determine the capacity of the instructional package in enhancing retention of students in Chemistry; and

iv. evaluate the effect of the package on students' attitude towards Chemistry.

Research Hypotheses

H01: There will be no significant difference in the performance of Chemistry students exposed to the Locally Produced Hypermedia Instructional Package (LPHIP) and those taught using conventional method.

H02: There will be no significant difference in retention ability of Chemistry students exposed to the LPHIP and those taught without the package.

Methodology

Research Design

This is a developmental study which employed a mixed method approach. The mixed method approach is divided into two stages. In the first stage, the hypermedia instructional package was designed and developed. In the second stage, an experimental design of pre-test post test control group was used to test the effectiveness of the package. A hypermedia instructional package has been designed, using multimedia developing tools which include Macromedia video works and web services to challenge and guide students to learn the basic concepts and technologies involved in the subject through interaction with computer. This package presents the basic concepts and technologies, step by step, to keep students' focus and interests on the topic and to help improve the quality of their learning outcomes. The package was produced based on design principles of instructional hypermedia systems. The information system within the package were hierarchized and contextualized in order to facilitate the understanding of its contents and in organizing the knowledge acquired through its browsing. The package was based on Acid Base and Salt aspect of Chemistry which was used to teach the experimental group.

The package begins with an overview of the Chemistry of acid, base and salt, followed by an introduction to the concept of acids, ionization of acids in water, the concept of bases, reactions of acids and bases, the strength of acids and bases, and the concept of salts.

The material is produced on a CD-ROM that contains the hypertext material, video and pictures. These high-quality texts and videos add a new dimension to

learning Chemistry. To see an acid in action gives the user a mental reference or orientation basis with which to relate the theoretical knowledge acquired to the implementation of that knowledge.

Sample and Sampling Procedure

For the purpose of this study, two private secondary schools with sufficient Computer facilities were purposively selected based on availability of functional computer hardware. From the selected schools, two intact senior secondary two Science classes were then purposively selected based on their ability to carry out basic operations on the computer. Roseful International High school, Osogbo served as the experimental group, while Henry Alex Duduyemi Memorial College in Ile-Ife served as the control.

Research Instruments

The main research instruments for this study are : (a) a twenty item test used for performance pre-test and post-test and retention tests titled Hypermedia Learning Achievement Test (HLAT). The HLAT contains twenty Multiple-Choice items on Acid, Base and Salt aspects of chemistry; and (b) A twenty item Chemistry Learners' attitude Towards Hypermedia Instruction Inventory (CLATHI)

Stimulus Material

Hypermedia instructional package served as the stimulus material in this study. The Stimulus material was named Hypermedia Instructional Package (HIP). The package was designed using Macromedia video works and web services, based on design principles of instructional hypermedia systems, which involves the application of the constructivist theory of learning as well as the Cognitive flexibility theory of Knowledge acquisition. Macromedia video works and web services were used in order to challenge and guide students to learn the basic concepts and steps involved in learning

the subject through interaction with computer. The concepts were presented in a non-linear fashion, but step by step to keep students focus and interest on the topic and to help improve the quality of their learning outcomes. The information system within the package were hierarchized and contextualized in order to facilitate the understanding of its contents and in organizing the knowledge acquired through its browsing.

The package was based on Acids, Bases and Salts aspect of chemistry which was used to treat the experimental group. The package begins with an overview of the Chemistry of acids, bases and salts, followed by an introduction to the concept of acids, ionization of acids in water, the concept of bases, reactions of acids and bases, the strength of acids and bases, the pH scale and the concept of salts were also included.

The material was produced on a CD-ROM that contains the hypertext, video, pictures and web links. The high quality texts and videos add a new dimension to the learning of chemistry. To see an acid in action gives the user a mental reference or orientation basis with which to relate the theoretical knowledge acquired to the implementation of that knowledge.

The control group was exposed to the Conventional Teaching Approach in Chemistry (CTAC). The CTAC contains carefully prepared lesson notes on Acid, Base and Salt aspect of Chemistry. The researcher, assisted by Chemistry teachers and research assistants, administered these instructional materials.

Validation of the Instrument

In order to ensure content validity, the Chemistry content of the Hypermedia Instructional Package was carefully organized in accordance with the Chemistry Syllabus prepared for Senior Secondary Schools in Nigeria.

Table 2: Mean, Standard deviation and differences in Performance scores of students in the experimental and control groups.

TEST	GROUP	N	\bar{X}	SD	Std.Error		p	Remark
					Mean	t		
Pre-test	Conventional	30	7.80	2.25	.41			Not
	Experimental	30	7.87	2.13	.39	.115	.909	Significant
Post-test	Conventional	30	12.00	2.48	.45			
	Experimental	30	15.37	2.17	.40	.458	.000*	Significant

*p < 0.05

Table 3: Mean Standard deviation and differences in retention scores of Subjects in the Experimental and Control Groups.

GROUP	N	\bar{X}	Sd	Std. Error		P	Remarks
				Mean	t		
Conventional	30	11.73	2.46	.45	-6.842	.000*	Significant
Experimental	30	15.87	2.18	.40			

*p < 0.05

Table 4: Mean, Standard deviation and differences in Attitude scores of Subjects in the Experimental and Control Groups.

TEST	GROUP	N	\bar{X}	SD	Std.Error		p	Remark
					Mean	t		
Pre-test	Conventional	30	52.53	7.29	1.33			Not
	Experimental	30	53.93	10.72	1.96	1.509	.142	Significant
Post-test	Conventional	30	52.73	3.97	0.73			
	Experimental	30	82.90	13.51	2.47	15.484	.000*	Significant

*p < 0.05

The validation of the instrument employed for this research was carried out by the following professionals, who adjudged both the face and content validity of the instrument used. They are:

Science curriculum development and implementation specialists both in the department of Special education and Curriculum studies and in the Osun State Ministry of Education, Osogbo; Instructional and educational technologists; and test and measurement experts.

Reliability of the Instruments

A pilot study was conducted in a school that was not part of the study to test the reliability of the instruments. To determine whether or not the instruments were reliable, the results of data collected from the pilot study were subjected to KR-20 reliability coefficient. The Cronbach's alpha reliability coefficient for the HLAT was given as 0.72, while the Cronbach's alpha reliability index for the CLATHI was 0.84. Since these reliability coefficients were high and above 0.5, then the instruments were adjudged good for the purpose for which they were constructed.

Procedure for Data collection

The experiment lasted a period of six weeks of three periods per week. The first week was used for pre-test and preparation of learners, which include short computer training. Students in both experimental and control groups were exposed to the pre-test before they were exposed to the instructional package and conventional teaching respectively. The pre-test featured the administration of the Hypermedia Learning Achievement Test, HLAT. The same HLAT used for pre-tests was also employed for post-test and retention test. By the second week each group were exposed to treatment. The experimental group was exposed to the locally produced hypermedia instructional package and they were allowed to browse through its content, by carefully studying the contents required per lesson. This continued for the experimental group till the fourth week.

As for the control group, lesson one was meant for general introduction to Acid, Base and Salt. Types of Acids and their characteristics were taught in the second lesson; the third lesson was used for teaching ionization of Acids in water. Definition of bases and

types were taught in the fourth lesson as well as their characteristics. The reactions of Acids and Bases were treated in the fifth lesson while acids and bases strengths were taught in the sixth lesson. At the seventh lesson the scale and other concepts related to it were treated. The eighth lesson was employed for the teaching of Salts and their characteristics. The ninth lesson of the fourth week was used for post-test of learners in both groups. During the fifth week, the CLATHI was administered on students. The sixth week was however employed for the retention tests. The sixth week was however employed for the administration of the retention test.

Results and Findings

The results from the findings based on the hypothesis formulated were summarized as follows: Hypothesis One states that there will be no significant difference in the performance of Chemistry students exposed to the Locally Produced Hypermedia Instructional Package (LPHIP) and those taught using conventional method. To test this hypothesis, the pre-test and post-test scores of participants in the experimental and control groups were subjected to the t-test of significance. The results are presented in table 2.

From table 2, subjects in the Conventional (Control group) had a pre-test mean score of 7.80 in the achievement test with a deviation of 2.25 while subjects in the HIP group has a mean value of 7.87 and a standard deviation of 2.13. When the mean and standard values were subjected to t-test of significance, a t-value of 0.115 was obtained at p = 0.909 and df of 58, which is not significant at 0.05 level. This shows that the subjects in the two groups have the similar entry behaviour.

On the other hand, as shown in Table 1, the post-test mean score of subjects in the conventional group was 12.00 with a standard deviation of 2.48. Also, in the HIP group, a post-test mean score of 15.37 and a standard deviation of 2.17 were obtained. These scores were subjected to t-test of significance and a t-value of 5.458 was obtained with p= 0.000 and a df of 58 which is significant at 0.05. This implies that there is a significant difference in the post-test mean scores of subjects in the two groups, hence the null hypothesis was rejected. Thus students who were exposed to the HIP understood Acids Bases and Salts more and

performed better in the achievement test than students who were taught with the conventional teaching method.

Hypothesis Two states that there will be no significant difference in the retention ability of Chemistry students exposed to the LPHIP and those taught without the package.

Table 3 indicated that subjects in the conventional group had a mean score of 11.73 and a Standard deviation of 2.46, while subjects in the LPHIP group had a mean value of 15.87 and a Standard deviation of 2.18 in the retention test. When these scores were subjected to a t-test of significance, a t-value of -6.482 was obtained with a p value of 0.000 and df of 58. Since the p value is less than 0.05, the null hypothesis which states that there will be no significant difference in the retention ability of Chemistry students exposed to the instructional package and those taught without the package is rejected. This result indicates that a significant difference existed in the retention abilities of the two groups. The retention being significantly higher in the group exposed to the LPHIP. Therefore, the LPHIP enhanced greater retention ability in the learned material.

Discussions

Effect of Locally Produced Hypermedia Instructional Package on Students Performance in Chemistry.

Hypothesis one was tested to examine the effectiveness of the locally produced hypermedia instructional package on students' performance in Chemistry. The result on the analysis of hypothesis one revealed that there was a significant difference in the post-test mean scores of the students exposed to the LPHIP and those taught with the conventional teaching method. The better performance of the experimental group could be attributed to the treatment, that is, the use of LPHIP for the experimental group. From the findings it can be inferred that the use of the stimulus material, that is the LPHIP for learning Chemistry could enhance significantly the performance of learners in the subject. It is therefore more advisable to learn Chemistry in our secondary schools with instructional packages than the Conventional teaching method. This study agrees with the findings of Tekmen (2006); Pektas (2008); Yildiz (2009); Sengel & Ozden (2009). These researchers determined that the use of stimulus material such as this significantly affected the academic performance of students. These researchers had discovered that stimulus materials could enhance significantly the performance of learners. The case with the Hypermedia Instructional package used for this study which from the results of the experiment showed a significant improvement in the performance of learners is not different. Moreover, the package being a locally produced one bears more relevance to the environment and culture of the learners, unlike many other packages used elsewhere that are foreign. This

also is likely to have being responsible for a better performance on the part of the experimental group.

Puntambekar (2003) also reported an improvement in students' performance in his investigation on the relation between improving students' performance and instructional aids effects in a hypermedia environment in relation to students' performance improvement. The improvement in performance reported tallied with the findings of this study. This study therefore established the effectiveness of the use of hypermedia for learning and its effect on performance.

Effect of Locally Produced Hypermedia Instructional Package in Enhancing Retention of Students in Chemistry.

Hypothesis two was used to test for the significant difference in the retention mean scores of students exposed to the LPHIP and those taught with the conventional classroom instruction. Findings from this hypothesis showed that students that were exposed to the LPHIP had a significantly better retention because some of the factors that cause loss of retention might have been reduced by the use of the package. Some of these factors include visual presentation, motivation and interest. This finding is in line with the report of Tekmen (2006); Yildiz (2009); Akilli (2008). Diverse learning and cognitive styles are favoured during multiple presentations of information as could be found in hypermedia learning package, retention is thus improved, performance enhanced, leading to increased motivation to learn. Hypermedia environments are more engaging, support various interests and cognitive styles, support independent and self-directed learning, increase retention and performance, and enhance critical-thinking as well as problem-solving skills in the course of exposing learners to multiple perspectives.

The software provides for flexible and interactive learning as it allows non sequential or nonlinear access to the elements, this might have been responsible for the better retention observed. Hypermedia software through its multimodal presentation has been found effective for accommodating the needs of different learners in learning cognitive and procedural information. Acquiring procedural knowledge in this context could also allow for better retention of concepts learnt.

Effect of Locally Produced Hypermedia Instructional Package on the attitude of students towards Chemistry.

Hypothesis three was used to evaluate the effect of the Locally Produced Hypermedia Instructional Package on the attitude of subjects exposed to the package and those taught with conventional classroom instruction. Hypothesis three stated that there will be no significant difference in the attitude of Chemistry students exposed to the LPHIP and those taught without it. Results of the data analyzed showed that there was a

significant difference in the attitude of students exposed to the LPHIP and those taught with the conventional teaching method. From the values obtained in Table 4.3, there was an increase in the attitude mean scores of students in the LPHIP group compared with the attitude scores of students in the control group. This indicates that the use of the LPHIP led to a positive change in attitude of learners.

The motivation the students received through their interaction with the package as well as its non-linear structure, which allow learners to control their learning pace, and offer numerous types of navigation support, might have been responsible for the positive change in attitude observed on the part of the students exposed to the package. The non-linear structure it provides also affords students the freedom of navigation, giving them opportunities to select what information to access as well as how to sequence the information in a manner that is meaningful to them. These as well increased students' interest and attitude towards learning. This result conforms to the studies of Akcay, Tuysuz and Feyzioglu (2003); Pilli (2008); Tavukcu (2008); Sengel & Ozden.

Conclusion

Based on the findings of this study, it was concluded that: The use of locally produced hypermedia instructional package produced a significant improvement in the post test mean performance of Chemistry students in Osun State. Moreover, the utilization of locally produced hypermedia instructional package produced a significant improvement in the retention ability test scores of Chemistry students in Osun State.

Recommendations

This study has implications for developers and designers of hypermedia. The use of hypermedia as a means of learning has actuated a good deal of research due to progressions in computer engineering. Developers and designers of hypermedia demand hypermedia road maps. This hypermedia instructional package was used to represent structural knowledge. It visually depicts interrelationships among concepts, presents information on domain knowledge hierarchically, and allows learners to gain an overview of the topic they are learning.

Based on major findings from this study, the following recommendations were made:

- i. Chemistry instructors should embrace the use of locally produced hypermedia instructional package for teaching Chemistry.
- ii. Learning Resources centers should be established in all schools for the production, storage and maintenance of instructional and media materials.
- iii. The use of Hypermedia for instruction should be made popular among educational technologists.

iv. Teachers and students should be well trained in order to acquire the necessary knowledge and ability required to use hypermedia instructional package for effective learning.

v. More computer Based instructional packages that have been found effective for teaching and learning should be employed in our schools to enhance better knowledge acquisition.

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