



## EFFECTS OF PROGRAMMED INSTRUCTIONAL PACKAGE ON SECONDARY SCHOOL STUDENTS' INTEREST IN ELECTROLYSIS

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### ABSTRACT:

The incidence of poor achievement in Chemistry is commonplace in secondary schools among students. This has been attributed to students' low interest in the subject and the use of inappropriate teaching methods by Chemistry teachers. In order to empirically substantiate these assertions and to possibly proffer lasting solutions, this study set out to determine the effects of Programmed Instructional Package on Students' Interest in Electrolysis. The study adopted a quasi experimental design based on the pre-test post-test, non-equivalent control group approach. A total of 1,750 Chemistry SS II students from Port Harcourt Education Zone constituted the population for the study. The sample consisted of 161 SS II Chemistry students. Four secondary schools were randomly selected out of twelve secondary schools. Two schools were assigned to the experimental group and the two to the control group. Intact classes were used in teaching. The experimental group students were taught Electrolysis using the Programmed Instructional Package (treatment) while the control group students were taught using the Chalk and Talk Teaching Method (control). The instrument for data collection was the Electrolysis Interest Inventory (EII) which was face validated by three experts; two in Chemistry and one in Measurement and Evaluation. After factor analysis, the reliability of Electrolysis Interest Inventory (EII) was determined using the Cronbach's Alpha Statistic and established as 0.93. Three research questions guided the study and three null hypotheses were tested for significant difference at 0.05 alpha level. Adjusted mean and standard deviation were used to answer the research questions while the hypotheses were tested using Analysis of Covariance (ANCOVA) at  $p > 0.05$  level of significance. Results of the study showed that (i) mean interest score of students in the Programmed Instructional Package group (the experimental group or treatment group) was higher than that of the students in the Chalk and Talk Teaching Method group (control group). (ii) Female students had higher interest mean score than the males. (iii). There was no interaction effect of teaching methods and gender on students' interest mean score. (iv) there was a significant difference in interest mean score of students taught Electrolysis using Programmed Instructional Package and those taught using Chalk and Talk Teaching Method at 0.05 alpha level. (v). interest mean scores for gender was not significant. (vi). There was no significant interaction effect of teaching methods and gender on students' interest mean score. Based on the results of the study, it was recommended that Programmed Instructional Package should be adopted by Chemistry teachers in teaching Electrolysis to secondary school students. Secondly, the method should be applied to close the gap in interest differences between male and female students.

### KEYWORDS:

**ELECTROLYSIS, PROGRAMMED INSTRUCTIONAL PACKAGE, INTEREST, CHALK AND TALK TEACHING METHOD, CHEMISTRY**

### BACKGROUND TO THE STUDY

Science and technology have always been recognized as basic tools of industrialization and national development and could bring economic and social satisfaction, providing employment and improving the welfare of citizens. Science as a subject has many branches such as; applied science, social science, natural science among others. Courses in natural science include biology, physics and Chemistry which are taught in both senior secondary and tertiary institutions as single subjects (Gongden, 2016).

Chemistry is one of the core subjects in the senior secondary school certificate and remained the most registered natural science after biology (WAEC, 2013, 2014). Chemistry is a subject that deals with the composition, properties and uses of non living matter. It

probes into the principles governing the changes that matter undergoes (Ababio, 2015). Igwe and Nwali, (2015) averred that Chemistry is preoccupied with the molecular transformation and manifestation of matter implying that Chemistry is involved in some industrial set ups such as fertilizers, cement, plastics, medicine, engineering, agriculture and in improving the life of citizens. As a result, Jantur in Njoku and Ezinwa (2014) pointed out that Chemistry is perceived to be the fulcrum in which all sciences and technology hinge for national development. In other words, Chemistry is a precursor of science and technology and an indispensable element in modern societal development (Igwe, 2016)

Chemistry has many branches namely organic Chemistry, inorganic Chemistry and physical Chemistry. Electro Chemistry is a topic in the physical Chemistry which has

oxidation and reduction, electrochemical cell, electrode potential and Electrolysis as subtopics. Electrolysis is defined as a chemical decomposition of a component brought about by a direct current passing through either in a solution of the compound, or the molten compound (Ababio, 2015). It was noted by West Africa Examinations Council (WAEC) Chief examiners' reports (2012, 2013,

2014) that questions in Electrolysis have continued to pose difficulty for candidates in external examination. This poor achievement could be traced to the method used in teaching the subject, which may have contributed to the yearly poor achievement of students in Chemistry in public examination such as WAEC as seen in the result shown in Table 1.

**TABLE 1: STUDENTS' ACHIEVEMENT IN CHEMISTRY IN SENIOR SECONDARY SCHOOL CERTIFICATE EXAMINATION (SSCE) FOR 2012-2020**

Year	Number that registered for the examination	Number that sat for the examination	% that sat for the examination	Total % credit grade 1 – 6	Total % pass Grade 7-8	Total % Fail F9
2012	496895	493397	99.30	14.26	19.40	66.34
2013	513263	498378	97.10	21.40	20.50	58.10
2014	565886	555361	98.14	24.35	26.67	48.98
2015	639296	628748	98.35	28.12	18.20	53.68
2016	639296	635844	99.46	20.16	22.40	57.44
2017	666168	635844	98.15	28.14	31.20	40.66
2018	658564	654086	99.32	20.10	14.10	65.80
2019	667237	657762	98.58	21.17	18.30	60.53
2020	704302	698668	99.20	23.30	15.20	61.50

**Source:** West African Examination Council Office, Lagos (2020).

This poor achievement could be traced to lack of interest in the students and poor methods of teaching adopted by the Chemistry teachers. Interest is a kind of awareness or indication for understanding the world and acquiring cultural and scientific knowledge (Odo, 2019). Ador (2019) sees interest as a degree of likeness individual has for something which could be an activity, person or situation. Interest therefore, deals with an individual preference for a particular type of activity (Samuel, 2018) needing his/her ability. Interest is not only a means but is an educational end in itself. According to Ador (2019), interest has a great impact on students' achievement while students' poor achievement in Chemistry had been attributed to by poor teaching method applied by Chemistry teachers (Samuel 2017; Odo, 2019).

Teaching is a process of transferring knowledge from teacher to the learner (Samuel, 2018) in order to help the learner develop the required ability to make the right choices while a teaching method comprises the principles and means to enable students' learning. Therefore, the teacher uses different teaching methods in order to enhance students' interest. Some of the teaching methods include lecture methods, demonstration methods and discussion method among others. These methods are teacher-centered because there is no active interaction between the students and teacher during the knowledge transfer that could promote interest. These teacher-centered methods of teaching also referred to as conventional teaching methods (Ajayi, 2017) or traditional

methods (Odo, 2019) tend to emphasize rote learning and do enhance interest. Hence, they are considered by many researchers as poor method of teaching as they do not encourage initiative, curiosity and creativity in learners (Dalgai and Adamu, 2019).

In the same vein, Ajayi (2017) had opined that lack of students' interest in Chemistry may be attributed to the use of conventional methods of teaching such as lecture, discussion and demonstration methods. Moreso, Igwe (2017) posited that teacher-centered methods stifle students' interest and consequently lead to low understanding of contents taught. These disadvantages of teacher-centered method of teaching have resulted to the quest for a teaching method that will encourage students' active participation that would enhance and sustain their interest during knowledge transfer in order to improve their achievement in the subject. Hence need for student-centered teaching methods to be adopted in teaching Chemistry in secondary schools.

The student-centered teaching methods are methods of teaching where the teacher acts as the facilitator while the students take the responsibility for their learning. Student-centered teaching method can also be called child-centered teaching method (Audu, 2018). Some examples of student-centered teaching methods include simulation games, guided discovery, cooperative learning strategy, jigsaw learning strategy and Programmed Instructional strategy among others. It is the Programmed Instructional Strategy that this paper has used to explore

its effects on students' interest in Electrolysis aspect of Chemistry.

Programmed instruction is a method of presenting new subject matter to students in a graded sequence of controlled steps. Students work through the programmed materials by themselves at their own speed and after each step, test their comprehension by examination or fill-in-diagram (Molenda, 2017). Programmed instruction was formulated by B.F. Skinner as a student-centered teaching method which improves teaching and learning activities (Wangila, Martin and Ronald, 2015). There are two types of programmed instructions namely; linear and branching programmed instructions which could be paper based or device based. The linear type will be involved in this study. Features of linear programmed instruction include:

- i. The material is broken down into small steps called frames which are presented in logical sequence. Each frame has just minimal information.
- ii. Students are required to make frequent responses (one, two or three) in frame the responses being made promptly to ensure that correct answers are made.
- iii. Linear programmed instruction provides immediate knowledge of results which act as a reinforce.

Programmed instruction is gender friendly, student-centered, encourages curiosity, active learning and mastery of content taught. Some researchers have reported the prevalence of significant gender differences in interest mean score of students, some in favour of males, and some in favour of females while some found no difference (Igwe, 2017). With the above inconclusive report on the interaction effect of gender of teaching strategies on students' interest, a new teaching method could be sought in teaching Electrolysis. It is then imperative to investigate the effects of Programmed Instructional Package on secondary school students' interest in Electrolysis sequel to the afore-mentioned qualities of the strategy.

The theoretical framework of this study is centred on the cognitive theory of learning and the behaviourism theory. Cognitive theory of learning is the most widely used theory in learning while the behavioural theory creates insights necessary for gaining deeper understanding of students' interest/attitude and achievement in learning. Cognitive development refers to how well a student is able to understand process and produce outcome. Cognition is a process through which students demonstrate increasing mental gap over the environment and more independence of thought from their immediate surroundings (Vikoo, 2003). The theory backing this study is the B. F. Skinner's Operant Conditioning

The famous psychologist, Skinner (1957-1976) propounded this theory, which is often called behavior modification or positive reinforcement theory. Operant

conditioning is essentially based on the fundamental concept of learning theory and is a method of learning that occurs through reward and punishment for behaviours. In positive reinforcement, a response or behavior is strengthened by reward leading to the repetition of desired behavior. The reward is the reinforcing stimulus. The basic concept behind the idea of operant conditioning is that behavior is determined by its consequences, be them reinforcement or punishment which makes it more or less likely that the behavior will occur.

Skinner's theory is based upon the idea that learning is a function of change in overt behavior and the changes in behavior are the result of an individual response to events (stimuli) that occur in the environment. In this case, a response produces a consequence (i.e. such as defining a word, hitting a ball), and when (i.e. particular) stimulus response (S-R) pattern is reinforced (rewarded), the individual is conditioned to response. Reinforcement is therefore the key element in Skinner's S-R theory. A reinforce is anything that strengthens the desired response, which could be a good grade or satisfaction or a feeling of increased accomplishment.

Skinner in 1950 introduced the concept of teaching machine. The teaching machine is composed of many programs, which is a system of combined teaching and test items that carries the student gradually through the material to be learned. The machine is composed of fill-in-the-blank method or with the workbook or a computer. If the answer is correct, the student gets reinforcement and move to the next question, if the answer is not correct the student studies the comprehension in other to get the correct answer which will increase the chance of getting reinforced next time. Skinner stated that the student should compose his response on his own rather than choose it among a large range of possibilities because the response could not be recognized but recalled. According to Skinner the machine should present information in a designed sequence of steps.

Operant conditioning is involved in this study. In programmed instruction the subject is the student itself, the aim is his/her own understanding of the learning materials and the reinforcement refers to satisfaction resulting from the comparison of students' responses and answers with the answer given by the computer. The machine helped the students to give correct answer by a logical presentation of the learning material. The implications of reinforcement theory as applied in this study are as follows:

- Practice took the form of question (stimulus) S-R answer (response) frame which exposed the student to subject in a gradual step.
- The student made a response for every frame and receives immediate feedback.
- The student tried to arrange the questions in order of difficulty so that the response was always correct and have a positive reinforcement.

- Ensured good achievement in lesson with secondary reinforces such as good grades or correct response.

Skinner's operant conditioning theory is involved in this study because apart from its features and principles, the procedures involved in Programmed Instructional Package conform with the formation of frames which are arranged in small steps, frames and the learning material are logically sequenced providing the text in a simplified form which are easier for students' comprehension and for the correct answers to be provided for the students to compose their own answers.

### STATEMENT OF THE PROBLEM

Notwithstanding the various importance of Chemistry in science and technology in national development, students' achievement in Chemistry especially in the aspect of Electrolysis has been persistently poor. This observed poor achievement could be an indication of students' lack of interest in Chemistry which might have been as a result of the teaching methods used by the Chemistry teachers. Electrolysis is mostly taught in secondary schools by lecture method, demonstration method or discussion method. All these methods of teaching are teacher-centered. They do not encourage initiatives, curiosity and creativity in students that enhance interest in learning. Also, they stifle students' interest and consequently lead to low understanding of contents taught. There is therefore, the need to adopt a teaching method that is student-centered; one that encourages students' active participation to enhance students' interest for mastery of the subject taught.

The low interest of the students has been a source of worry to these researchers as the situation could lead to low scientific and technological development of the society and low standard of living if the low interest persists. It is also on record that there is no known empirical evidence of the use of this strategy to promote interest in learning and teaching of Electrolysis. The problem of this study in question form is "what is the effect of Programmed Instructional Package on secondary school students' interest in Electrolysis"?

### PURPOSE OF THE STUDY

The main purpose of the study was to determine the effects of Programmed Instructional Package on secondary school students' interest in Electrolysis. Specifically, the study determined:

1. The effect of Programmed Instructional Package on secondary school students' interest in Electrolysis.
2. The effect of Programmed Instructional Package on male and female Chemistry students' interest in Electrolysis.
3. The interaction effect of teaching methods and gender on Chemistry students' interest in Electrolysis.

### SIGNIFICANCE OF THE STUDY

The results of the study would be beneficial to the following stakeholders: Chemistry students, science teachers, schools' authorities, Federal and State Ministry of Education, Local Government Education Authority, tertiary institutions especially institute of education, curriculum planners, and textbook authors.

To the students the result would: make the concept of Electrolysis in such a way that it would no longer be abstract and difficult to understand as it enhances interest. It would help the students to understand other Chemistry concepts that are related to Electrolysis to improve their performance in Chemistry examinations.

To the teachers, the result would help them to plan and develop classroom practices that would enable students to develop higher interest in learning, enhance their problem-solving skills and become confident learners.

To the school authorities, the result will sensitize them on the use of Programmed Instructional Package and its extension to other subjects in order to improve students' interest.

To Federal and State Ministry of Education and Local Government Education Authorities the result would enable them to liaise with Institute of Education to conduct in-service training for teachers through organizing seminars and workshops to understand this strategy.

To the curriculum planners the result would enable them to construct curriculum that enhances intellectual substance with Programmed Instructional Package in view. It would help to form a basis for the review of weak areas of Chemistry curriculum appropriately especially as it affects pedagogy, specifies the activities that are learner-centered and enhances interest in the students.

To the publishers and professional bodies, the result would sensitize them in the development of textbooks in line with the Programmed Instructional Package format.

### SCOPE OF THE STUDY

The study was delimited to determining the effects of Programmed Instructional Package on secondary school students' interest in Electrolysis in Port Harcourt Education Zone of Rivers State, Nigeria. It also explained the interactive effect of Programmed Instructional Package and Chalk and Talk method and gender with respect to interest mean score in Electrolysis. The study made use of secondary school two (SSII) students who offer Chemistry as one of their subjects in WAEC and Electrolysis as a topic in secondary school (II) Chemistry syllabus.

### RESEARCH QUESTIONS

THE STUDY WAS GUIDED BY THE FOLLOWING RESEARCH QUESTIONS.

1. What is the interest mean score of students taught Electrolysis with Programmed Instructional Package and those taught with Chalk and Talk Teaching Method?
2. What is the interest mean score of male and female students taught Electrolysis with

Programmed Instructional Package?

3. What is the interaction effect of teaching methods and gender on the interest mean score of students in Electrolysis?

## HYPOTHESES

THE FOLLOWING HYPOTHESES WERE TESTED AT 0.05 ALPHA LEVEL:

1. There is no significant difference in the interest mean score of students taught Electrolysis with Programmed Instructional Package and those taught with the Chalk and Talk teaching Method.
2. There is no significant difference in the interest mean score of male and female students taught Electrolysis with Programmed Instructional Package.
3. There is no significant interaction effect of teaching methods and gender on the interest mean score of students on Electrolysis.

## METHODOLOGY

The procedures adopted by researchers in carrying out this study are stipulated here.

### DESIGN OF THE STUDY

The research design adopted was pretest-posttest, non-equivalent control group quasi-experimental design. The design is represented symbolically thus:

$$\begin{array}{cccc} E & O_1 & X_1 & O_2 \\ \hline C & O_1 & X_2 & O_2 \end{array}$$

Where  $O_1$  and  $O_2$  represent pre-test and post-test respectively,  $X_1$  is treatment for Programmed Instructional Package group and  $X_2$  is treatment for the Chalk and Talk Teaching Method group. E is experimental group (Programmed Instructional Package) and C control group (Chalk and Talk Teaching Method).

### AREA OF THE STUDY

The study was carried out in Port Harcourt education Zone of Rivers State, Nigeria. Rivers state is bounded on the South by the Atlantic Ocean, to the North by Anambra, Imo and Abia States, to the East by Akwa Ibom State and to the West by Bayelsa and Delta States. Rivers State is currently made up of 23 Local Government Areas. The Local Government Areas are Abua/Odua, Ahoada-East, Aboada-West, Akuku-Toru, Asari Toru, Andoni, Bonny Degema, Eleme, Emohua, Etche, Gokana, Ikwerre, Khana, Obio/Akpor. Ogba/Egbema/Ndoni, Ogu/Bolo, Okrika, Omuoma, Opobo/Nkoro, Oyigbo, Port Harcourt and Tai. Port Harcourt Local Government Area is located 52 kilometers southeast of Ahoada and about 40 kilometers Northwest of Bori. It is bounded to the South by Okrika, to the East by Eleme, to the North by Obio/Akpor and to the West by Degema. The choice of the area for this study is due to the fact that despite Port Harcourt being a capital city with good and well equipped secondary schools, presence of highly qualified Chemistry teachers; students still perform poorly in Chemistry in public examinations.

## POPULATION OF THE STUDY

The population of the study comprised 1,750 senior secondary (II) Chemistry students from Port Harcourt Education Zone of the State, from twelve (12) secondary schools. This population was made up of 763 male and 987 female Chemistry students. The choice of this topic was guided by the fact that Electrolysis was taught in SS2 of the senior secondary school in Nigeria and it poses difficulty to students. The zone has twelve secondary schools that consistently offer students for WAEC Examinations.

## SAMPLE AND SAMPLING TECHNIQUES

The treatment group had 40 males and 25 females while the control group had 35 males and 61 females, giving a total sample of 161 students. Purposive sampling technique was used to select four (4) out of the twelve (12) senior secondary schools offering Chemistry. Then, random sampling was adopted to select the two secondary schools that were for the experimental group and two secondary schools for the control group respectively. Intact classes were used in each case of the secondary schools chosen for the study.

## INSTRUMENT FOR DATA COLLECTION

The instrument used to collect the data for the study was the Electrolysis Interest Inventory (EII). EII was researchers' developed interest inventory. It was used to elicit information on students' interest in Electrolysis. EII is a structured questionnaire and had two Sections A and B. Section A dealt with the issues of respondents' personal data (name of school, age, sex), while B dealt with information on students' interest in Electrolysis. Initial draft of Section B contained 44 items. This section was streamlined into clusters of Academic (17 items), Leisure (9), Vocational (8) and General (10). After validation the number of items dropped to 36 items of EII. The instrument (questionnaire) was defined along the 4-point rating scale of strongly Agree (SA = 4 points), Agree (A = 3 points), Disagree (D = 2 points), and strongly Disagree (SD = 1 point), for positive items whereas the reverse was made for the negative items. The students were required to tick against the option that represented their level of agreement with each statement by way of completing the instrument.

## VALIDATION OF THE INSTRUMENT

The EII was given to three experts: two in Chemistry and one in Measurement and Evaluation for face validation, all from University of Port Harcourt in Rivers State, Nigeria. The validators were required to vet EII instruments based on language clarity to students, content coverage of the items on the achievement test, relevance of the items to stated specific objectives and correctness of item options for the achievement test and adequacy of items for the interest inventory. Some of the items of EII were restructured but none was dropped.

The EII was then administered to thirty- three (33) students in the non-target schools in Ahoada Local Government Area for trial testing. Data collected from the

trial testing of EII from the forty four (44) items were subjected to factor analysis based on Principal Component Matrix (PCM). By varimax rotation approach of PCM eight items (2, 10, 12, 13, 15, 18, 23 and 29) dropped for poor loading, thereby leaving thirty-six (36) items for use.

### RELIABILITY OF THE INSTRUMENT

The EII was subjected to test of reliability using Cronbach Alpha statistic and based on the four clusters as follows: Academic (12 items) = 0.82, Leisure (7 items) = 0.69, Vocational (7 items) = 0.80, General (10 items) = 0.82. However, the entire 36 items gave a reliability coefficient was 0.93 which indicated a very high internal consistency and consequently showed that EII as an instrument was suitable for use for the study.

### EXPERIMENTAL PROCEDURES

This was done in two stages; (1) training of the research assistants (regular Chemistry classroom teachers of the class in the sampled schools) in the experimental group, and (2) application of treatment to the experimental and control groups. The researchers introduced themselves to Principal of the schools, who took them to meet the research assistants. The researchers introduced themselves to the research assistants who were the regular Chemistry teachers in the sampled schools for that class. The researchers explained vividly the objectives of the research to the research assistants and introduced the method as Programmed Instructional Package. They took time to explain to the research assistants how to use the Programmed Instructional Package. The training lasted for one week.

The Chalk and Talk Teaching Method was used for the control group. No training was given to the two research assistants in this group because they were to use the Chalk and Talk Teaching Method (they were conversant with it). The researchers provided the experiment group research assistants the website for Programmed Instructional Package and the lesson plans for the research assistants for the control groups which guided them during the teaching-learning process.

Before the experiment began, the EII was administered to both students of experimental and control groups as pre-test. The instrument was completed by the students and collated by the researchers. The scores were recorded as pre-test scores to be used to determine the students' initial interest on the materials they used in learning and also determine the comparability of the two groups (experimental and control) with respect to their interest in the pre-test scores.

### EXPERIMENTAL PROCEDURE FOR THE PROGRAMMED INSTRUCTIONAL PACKAGE (TREATMENT)

The implementation of the study involved the study of subtopics in Electrolysis using Programmed Instructional Package. The experimental group was subjected to Electrolysis Achievement Package (EAP) on the website which contained the objectives of each subtopic clearly

spelt out, the short comprehension passage on the topic in Electrolysis with the corresponding questions in form of fill-in-the blank spaces in a frame. The student studied the short comprehension passage and clicked on the bottom to supply the correct answer(s) and then clicked on the submit button to upload their answer(s). Correctly answered question(s) by the student, automatically sent him/her to the next frame. Wrong answer(s) gave a feedback that sent the student back to the passage for thorough understanding. Each student connected to the website to access the EAP and was required to study Electrolysis using it. The research assistant only attended to the students' problems when necessary as facilitators but not to teach them.

### EXPERIMENTAL PROCEDURE FOR THE CHALK AND TALK TEACHING METHOD

The Chalk and Talk Teaching Method was used to teach students (research subjects) in the control group in their sample schools. The research assistants (their classroom teachers) used verbalization for relevant concepts and principles in Electrolysis during the knowledge transfer using the lesson plan prepared by the researchers. The students watched and listened attentively during the teaching-learning process and took down notes, asking questions where necessary. The teaching lasted for the same period of six weeks as for the treatment group. During the period of this study, the researchers monitored the schools used to ensure that the research assistants (their classroom teachers) adhered strictly to the instructions given to them on administering the Programmed Instructional Package.

### POST-TEST

After the treatment, EII was reshuffled and administered to both students in experimental and control groups. This was the post-test. The scripts of the post-test were also marked by the researchers, and the scores were recorded. The procedure for the training was summarized as follows:

**1<sup>st</sup> WEEK:** visiting the participating schools used in the study to see the Chemistry teachers used for the study and to carry out the training of the research assistants on the use of Electrolysis Achievement Package.

**2<sup>nd</sup> WEEK:** Administration of EII to both the experimental and control groups by research assistants (their SS-2 classroom teachers) involved in the study. Scoring and recording of the pre-test scripts scores by the researchers.

**3<sup>rd</sup> – 8<sup>th</sup> WEEK:** Six weeks of exposing students of the experimental group to EAP (Electrolysis Achievement Package) while students in the control group were taught by the research assistants (their classroom teachers) using the lesson plans prepared by the researchers.

**9<sup>th</sup> WEEK:** Post-test administration of EII

### CONTROL OF EXTRANEOUS VARIABLES/CONDITIONS

The researchers took the following steps to checkmate the effects of the extraneous variables which might affect the

experimental results.

- i. **EXPERIMENTAL BIAS:** To avoid experimental bias regular classroom teachers in the participating secondary schools who used to teach the student Chemistry in SS II classes were used. The teachers (research assistant) administered the pre-test and post-test as class tests. The researchers came in as external observers.
- ii. **TEACHER VARIABILITY:** Normal Chemistry SS II teachers in each of the school under study were used. The classroom teachers involved in administering the instruments were properly trained by the researchers for the experimental group in order to ensure homogeneity of instruction across the group. Both the lesson plans and the programmed software on Electrolysis were prepared by the researchers. Students in the experimental group were exposed to programmed software on Electrolysis Achievement Package, while only the lesson notes prepared by the researchers were used by the teachers to teach the control group. The researchers supervised the exercise.
- iii. **EXPERIMENTAL FACTOR:** Each school did not have both experimental and control groups in order to avoid interferences. Different schools that were far apart were used in the experiment.
- iv. **INTER GROUP VARIABLE:** It was not possible to assign participants at random to both experimental and control groups. Hence, intact classes were used for the study, which meant that the initial equivalence was not achieved in the two groups. Hence the researchers employed Analysis of Covariance (ANCOVA) for data analysis in order to eliminate the error of non-equivalence. This controlled the initial differences of the participants in the intact classes.

- v. **HAWTHORN EFFECT:** This effect was controlled by using intact classes and their Chemistry teachers as research assistants, who were trained for both experimental classes.

### METHOD OF DATA COLLECTION

The EII was administered to both experimental and control group as pre-test before the treatment was started. This provided the pre-test scores as covariates. After the treatment, the post-test was administered to both experimental and control groups using reshuffled EII. The scores generated from the administration of pre-test and post-test on the Chemistry students using the Electrolysis Interest Inventory were used as the data collected for the research work.

### METHOD OF DATA ANALYSIS

Mean and standard deviation were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results of the hypotheses were interpreted thus: where  $p < 0.05$ , the result of the hypothesis was rejected and where  $p > 0.05$ , the result of hypothesis was not rejected.

### RESULTS

The results of data analysis were presented in Tables according to the research questions and hypotheses, thus:

#### RESEARCH QUESTION ONE

What is the interest mean score of students taught Electrolysis with Programmed Instructional Package and those taught with the Chalk and Talk Teaching Method?

The data collected on interest scale (pre and post-test) for both the treatment and control groups for students were used to answer this research question as summarized in Table 2.

**TABLE 2: INTEREST MEANS SCORE BASED ON TEACHING METHODS**

Teaching method	Number	Adjusted mean $\bar{X}$	Standard Deviation
Programmed Instructional Package	65	119.80	14.63
Chalk and Talk Teaching Method	96	90.14	6.20

Table 2 shows that the interests mean score of students taught Electrolysis using Programmed Instructional Package was 119.80 with standard deviation of 14.63. The interest mean score and standard deviation of students taught using Chalk and Talk Teaching Method were 90.14 and 6.20 respectively. The interest mean score of the students taught using the Programmed Instructional Package (119.80) is greater than the interest mean score (90.14) of those taught using Chalk and Talk Teaching Method. These results show that Programmed Instructional Package increased students' interest in Electrolysis more than Chalk and Talk Teaching Method.

Therefore, Programmed Instructional Package enhances students' interest in Electrolysis more than the Chalk and Talk Teaching Method.

#### RESEARCH QUESTION TWO

What is the interest mean score of male and female students taught Electrolysis with Programmed Instructional Package?

The data collected on interest (pre and post-test) for the treatment group only were used to answer this research question as summarized in Table 3.

**TABLE 3: INTEREST MEANS SCORE OF STUDENTS BASED ON GENDER**

Method	Male			Female		
	N	Adjusted mean $\bar{X}$	Standard deviation	N	Adjusted mean $\bar{x}$	Standard deviation
Programmed Instructional Package	40	119.60	15.67	25	120.12	13.09

From Table 3, it can be seen that the interest mean score and standard deviation of male students taught Electrolysis using Programmed Instructional Package were 119.60 and 15.67 respectively. The interest means score of female students in the group was 120.12 with the standard deviation as 13.09. Based on the mean values, female students had higher interest mean score than the male students when taught Electrolysis using Programmed Instructional Package.

**RESEARCH QUESTION THREE**

What is the interaction effect of teaching methods and gender on the interest mean score of students in Electrolysis?

Data collected using interest inventory (pre and post-test) for both treatment and control groups for both male and female students were used to test for interaction. Summary of result is shown in Table 4.

**TABLE 4: INTEREST MEANS SCORE BASED ON INTERACTION EFFECT BETWEEN TEACHING METHODS AND GENDER**

Methods	Gender			
	Male		Female	
	N	$\bar{X}$	N	$\bar{X}$
Programmed Instructional Package	40	119.60	25	120.12
Chalk and talk Teaching Method	35	89.37	61	90.57

The results in Table 4 reveals that the females had higher interest mean scores in both the Programmed Instructional Package as well as in the Chalk and Talk Teaching Method. This means that there is no interaction effects of teaching methods and gender on students' interest mean scores in Electrolysis.

Programmed Instructional Package and those taught with Chalk and Talk Teaching Method.

**HO<sub>3</sub>:** There is no significant interaction effect of teaching methods and gender on the interest mean score of students on Electrolysis.

**TEST OF HYPOTHESES ONE AND THREE**

**HO<sub>1</sub>:** There is no significant difference in the interest mean score of students taught Electrolysis with

Data collected using interest inventory (pre and post-test) for both treatment and control groups for both male and female students were used to test for significant interaction. Summary of result is shown in Table 5.

**TABLE 5: ANCOVA RESULTS OF INTEREST MEAN SCORE BASED ON TEACHING METHODS AND INTERACTION EFFECTS OF METHODS AND GENDER**

Source of variation	sum of squares	DF	Mean square`	F	Sig of F (p-value)	Alpha.
Covariates	5051.809	1	5051.809	46.353	0.000	
Pretest	5051.809	1	5051.809	46.353	0.000	
Main effects	29412.267	2	14706.133	134.935	0.000	
Methods	29396.173	1	29396.173	269.723	0.000	0.05
Gender	16.094	1	16.094	0.148	0.701	
2-way interactions	.001	1	.001	0.000	0.998	
Method x Gender	.001	1	.001	0.000	0.998	0.05
Explained	34464.076	4	8616.019	79.056	0.000	
Residual	17001.911	156	108.987			



Total	51465.988	160	321.662			
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Results in Table 5 revealed that the F-ratio for method was 269.723 with significance of F-value (p-value) as 0.000. The significance of F (0.000) is less than the alpha level 0.05, hence,  $H_{01}$  was rejected. This means that there is a significant difference at  $P < 0.05$ , between the interest's means scores of students who were taught Electrolysis using Programmed Instructional Package and those taught using Chalk and Talk Teaching method. This finding shows that the difference between the interest mean score was not by chance occurrence but systematic. Statistically the interest mean scores are not equivalent; hence, Programmed Instructional Package is superior to Chalk and Talk Teaching method in enhancing students' interest.

Results in Table 5 also reveal that with regards to interaction effect of teaching methods and gender, the significance of F (p-value) is 0.998. The significance of F

(0.998) is greater than the alpha level (0.05), therefore,  $H_{03}$  was not rejected (it is accepted). This means that there is no interaction effects of teaching methods and gender on students' interest mean score in Electrolysis. This finding is consistent with the finding in 4.1.3 that there is no interaction effect of teaching methods and gender on students' interest mean score.

### TEST OF HYPOTHESIS TWO

There is no significant difference in the interest mean score of male and female students taught Electrolysis with Programmed Instructional Package.

Data collected using the interest inventory (pre and post-test) for the treatment group only were used to test this hypothesis and the results are summarized as shown in Table 6.

**TABLE 6: ANCOVA RESULTS ON STUDENTS' INTEREST BASED ON GENDER**

Source of variation	sum of squares	DF	Mean square`	F	Sig of F (p-value)	Alpha. level
Covariates	1303.832	1	1303.832	6.526	0.013	
Pretest	1303.832	1	1303.832	6.526	0.013	
Main effects	13.080	1	13.080	0.065	0.799	
Gender	13.080	1	13.080	0.065	0.799	0.05
Explained	1316.912	2	658.456	3.296	0.044	
Residual	12387.488	62	199.798			
<b>Total</b>	<b>13704.400</b>	<b>64</b>	<b>214.131</b>			

From Table 6, the F-ratio for gender is 0.065 while the significance of F (p-value) is 0.799. The significance of F (0.799) is greater than the alpha level (0.05),  $H_{02}$  is not rejected. This means that there is no significant difference at  $P < 0.05$ , between the interests means score of male and female secondary school students when taught Electrolysis using Programmed Instructional Package. The fact that female students had higher mean interest score than male

students (see 4.1.2) cannot be attributed to the effect of treatment. Statistically, the interest mean scores are equivalent here.

### SUMMARY OF FINDINGS

The following is the summary of the findings of the research:

1. The interest mean score of students taught Electrolysis using Programmed Instructional Package was higher than the interest mean score of students taught using Chalk and Talk Teaching method. The test of the significant difference in the interest mean score of the treatment groups was significant statistically at  $p < 0.05$ .
2. The female students had higher interest mean scores than the male students. The interest

difference between these mean scores was however, not statistically significant at  $p < 0.05$ .

3. Female students had higher mean score than the males in the two teaching methods; hence, there is no interaction effect of teaching methods and gender on students' interest mean score. The interaction effect was not significantly different at  $p < 0.05$ .

### DISCUSSION

The results of the research were discussed as follows:

#### EFFECT OF PROGRAMMED INSTRUCTIONAL PACKAGE ON SECONDARY SCHOOL STUDENTS' INTEREST MEANS SCORE IN ELECTROLYSIS

The research question 1 set out to determine the effect of Programmed Instructional Package on secondary school students' interest mean score in Electrolysis. Results relating to this research question were presented in Table 2. Students who were taught using Programmed Instructional Package had higher interest mean score than those taught using Chalk and Talk Teaching method. This implies that the difference between the interest mean scores was systematic and not due to chance occurrence. The interest mean scores were not equivalent statistically,

hence, the Programmed Instructional Package is a very good package that can be used to enhance students' interest in Electrolysis.

The higher interest mean score of the students taught using Programmed Instructional Package may be due to presentation of the teaching-learning materials in the package, in a logically sequenced from simple to complex which made it easier for students' comprehension and mastery leading to answering the questions asked at the end of each frame. The ability to answer the questions correctly gives them satisfaction which enhances and sustains their interest in the topic during teaching and learning processes.

The result is in line with Gagne's Hierarchical theory which states that meaningful learning takes place in a gradual step from simple to complex. Also, the instructional package provided activities and feedbacks that helped the student in the learning process. The activities in the Package are such that aroused and sustained students' interest in both Electrolysis and the package itself. Besides, the Programmed Instructional Package enhanced the interest of the students because the instructional package was tailored to the needs and level of the students, with regard to the provision of recommendation of the Chemistry curriculum in use in their schools' textbook. This is in line with Bruner's Theory of learning and discovery and his theory of cognitive development which suggested that instructions at all levels should be geared towards the learning motivational development of cognitive operation.

This finding equally agrees with studies related to student centered innovative strategy in general and the Programmed Instructional Package in particular, enhanced student interest. Danjuma (2015) and Odo (2019) observed that interest in Chemistry depends on the pedagogy applied in teaching the subject. In the same vein, Ajayi (2017), Chikendu, Ejesi, and Abumchukwu, (2021) noted that interest in Chemistry depends on the innovative strategy applied in teaching the subject. Similarly, Udeh, Edeoga, and Okpube (2018) averred that the use of Programmed Instructional Strategy in teaching mathematics led to a higher interest mean score than the lecture method. This result also agrees with Okorie (2015) who studied the effect of Instructional Software Package Method of Teaching (ISPMT) on students' interest and achievement in Chemical Bonding at Nsukka Education Zone of Enugu State. The study found that the experimental group had a higher mean interest score than that of the control group. The result is in line with the work of Onuoha, et al (2016) on the effect of Concept Mapping Instructional Strategy on students' achievement and interest in Economics in secondary schools in Enugu Education Zone, Nigeria. The results showed that students who were taught economic using Concept Mapping Instructional strategy had higher interest mean score than their counterparts taught with the Lecture Instructional Strategy.

The test of significance of hypothesis 1 ( $H_{01}$ ) which stated

that there is no significant difference in the interest mean score of students' taught Electrolysis using Programmed Instructional Package and those taught with Chalk and Talk Teaching method, showed that there was statistically significant difference between the interest mean score of the treatment and control group. This emanated from the fact that the use of Programmed Instructional Package to enhanced students' interest in Electrolysis because the strategy is student-centered, innovative and provides activities and feedbacks that helped students in learning process. The activities were able to arouse and sustain their interest in the instructional package itself unlike the Chalk and Talk Teaching Method. This result agrees with Okorie (2015) who studied the effect of Instructional Software Package Method of Teaching (ISPMT) on students' interest and achievement in Chemical Bonding at Nsukka Education Zone of Enugu State and found that ISMPT had significant effect ( $p < 0.05$ ) on student's interest in Chemical Bonding.

### **EFFECT OF PROGRAMMED INSTRUCTIONAL PACKAGE ON THE INTEREST MEAN SCORE MALE AND FEMALE**

#### **SECONDARY SCHOOL STUDENTS' IN ELECTROLYSIS**

The research question 2 was sought to determine the interest mean score of male and female students taught Electrolysis with Programmed Instructional Package. It was found that female students had higher interest mean score than the male students. This shows that when Electrolysis is taught using Programmed Instructional Package, female students will show greater interest in Electrolysis than the male. The interest mean scores are systematically equivalent. This may be due to equal active participation of male and female student during the teaching-learning process using Programmed Instructional Package.

The equivalent interest across gender may have been due to the Programmed Instructional Package which allowed each student to work and progress at his/her own pace without undue pressure or a threat of being exposed to humiliation in a heterogeneous class or embarrassment from any quarters in case of any mistake in the course of the teaching-learning process. As a result, both genders were equally involved and mutually benefited from the gender friendly environment provided by Programmed Instructional Package.

The higher interest mean score of females agrees with that of Okeke (2015); Ajayi, Agamber and Angura, (2017) and Chikendu, Ejesi and Abumchukwu, (2021). On the contrary, Ajayi, (2017); Godpower-Echie and Ihenko (2017); and Odo (2019) observed in their various studies that male students had higher interest mean scores than the female in Organic Chemistry, integrated science and Chemistry respectively;

The test of significance of hypothesis 2 ( $H_{02}$ ) which stated that there is no significant difference between the interest

mean score of male and female students taught Electrolysis using Programmed Instructional Package was not rejected (accepted). Therefore, the difference between the interests means score was not significant. The difference in the interest mean score was therefore not systematic but may be chance occurrence. The result is in line with Odo (2019) who found that there was no significant difference in the mean interest scores of male and female students in their study of Organic Chemistry, Integrated science and Chemistry. The result is also in line with Ajayi (2017) who investigated the effect of Hands-on Activity-based Method on interest of senior secondary Chemistry students in Organic Chemistry in Makurdi Local Government Area of Benue State, Nigeria and found that male and female students in Hands-on Activity-based Method group did not differ significantly in their mean interest scores.

### **INTERACTION EFFECT OF TEACHING METHODS AND GENDER ON STUDENTS' INTEREST IN ELECTROLYSIS**

The result of Table 4 was used to answer the research question 3 which sought to determine the interaction effect of teaching methods and gender on the interest mean score of students in Electrolysis? The results in Table 4 reveals that the females had higher interest mean scores in both the Programmed Instructional Package as well as in the Chalk and Talk Teaching Method groups. This means that there is no interaction effects of teaching methods and gender on students' interest mean scores in Electrolysis. It follows that the dependence of interest mean score on gender did not change across teaching methods.

The nature of the result stems from the fact that the Package provided interactive and conducive learning environment which allowed the female students to work privately on its own pace more than the male students, make mistakes and learn from it without fear of punishment, embarrassment or humiliation by any classroom teacher. As a result of this learning environment both male and female are equally motivated resulting to not too great a difference in the results of male and female students. Therefore, the difference did not produce an interaction effect. On the contrary, Okeke (2015), and Amadi (2016) observed that there was interaction effect of teaching methods and gender in Chemistry and Biology respectively.

The test of significance of hypothesis 3 ( $H_{03}$ ) which stated that there is no significant interaction effects of teaching methods and gender on the interest mean score of students in Electrolysis, as in Table 5 revealed that the interaction effects of the teaching methods and gender on students' interest mean score in Electrolysis was not significant. This finding showed that Programmed Instructional Package did not discriminate between genders when used in teaching of Electrolysis.

This finding is consistent with that of Ajayi, Agamber and Angura (2017); Chikendu, Ejesi and Abumchukwu (2021), who in separate studies established that there was no

significant interaction effect of teaching methods and gender on students interest in Chemistry. In the same vein, Udeh, Edeoga and Okpube (2018) observed that there was no significant interaction effect between gender and the instructional methods on students' interest in mathematics.

### **EDUCATIONAL IMPLICATIONS OF THE FINDINGS**

The findings of this study have many implications for Chemistry education, thus:

It was found that students' who were taught Electrolysis using Programmed Instructional package had higher mean interest score after treatment than students who were taught using the Chalk and Talk teaching method. The implication is that if Chemistry teachers should use the Programmed Instructional Package to teach Chemistry students Electrolysis, students' interest in Electrolysis will be enhanced. On the other hand, failure to use the instructional package by Chemistry teachers will stifle students' interest and understanding of Electrolysis, resulting to poor performance.

It was found that the Programmed Instructional Package led to a higher mean interest score for female than for male students. The difference was however, not statistically significant, meaning that the Programmed Instructional Package did not discriminate substantially on the basis of gender. This finding has important implications for Chemistry education in that if Chemistry teachers should use Programmed Instructional Package, it will close the gap on interest between male and female students and increase inclusiveness in Electrolysis classes. Conversely, if Chemistry teachers do not use the Programmed Instructional Package in teaching Electrolysis, the students will not benefit from the instructional package's ability to increase the interest in female students and the inherent benefit of bridging the gap between the interest mean of male and female students in Electrolysis.

In terms of interaction effect of teaching methods and gender, there was no interaction effect of teaching methods and gender on students' mean interest score. This means that the mean interest score of students was not affected by any interaction of teaching methods and gender. The implication is that the uses Programmed Instructional Package will yield positive results in all male only or female only or mixed only Electrolysis class.

### **RECOMMENDATIONS**

BASED ON THE FINDINGS THE RESEARCHER RECOMMENDED AS FOLLOWS:

1. Chemistry teacher should use Programmed Instructional Package in teaching Electrolysis in secondary school as it enhances interest in students.
2. The curriculum for teacher-training programme in Institute of Education and Faculties of Education could be reformed and enriched with adequate ICT facilities that will enable teachers to develop

and use their own made educational software packages to make their teaching interesting and effective in order to enhance the interest of the students in the topic.

3. Workshops, conferences and seminars should be organized by Ministry of Education, Profession bodies like Science Teachers' Association of Nigeria (STAN), Teachers Registration Council of Nigeria (TRCN) to popularize and Sensitize Chemistry teachers on the efficacy of Programmed Instructional Package in teaching of Electrolysis in order to enhance interest of students.
4. Curriculum planners should incorporate this instructional package into the secondary school curriculum.
5. Publishers and professional bodies should develop Chemistry textbooks in line with the Programmed Instructional Package format.

### LIMITATIONS OF THE STUDY

1. The limited number of schools that had ICT faculties made it difficult for the research to use more schools.
2. The schools used were those that are either connected to the national grid or had a standby generator. There are sometimes delay in carrying out the teaching due to the epileptic supply of electricity from the national grid. The researchers had to fuel the generators to use for the study.
3. Some students were not ICT literate and had initial problem of assessing the lesson online.

### CONCLUSION

Available research evidence shows that students' interest in Chemistry was low and continues to decline. Similarly, secondary school students' have poor achievement in Chemistry due to this low interest. The persistent low interest in Electrolysis has been of great concern to Chemistry educators and researchers. Among the factors identified to be responsible for the low interest was the use of inappropriate teaching method used by the Chemistry teachers. The low interest has also been attributed to some difficult aspects of Chemistry like Electrolysis.

This study therefore sought to determine the effects of Programmed Instructional Package on secondary school students' interest in Electrolysis with the intention of using it to improve students' interest in learning Electrolysis and subsequently the achievement of students. The findings of the study showed that the use of Programmed Instructional Package can enhance students' interest greatly. The strategy is also gender friendly as it was confirmed to be effective in bridging the gap between male and female students' interest in Electrolysis.

The researchers therefore, are of the opinion that if Chemistry teachers should make effective use of Programmed Instructional Package, the problem of low interest in Chemistry and especially Electrolysis will be eradicated as the Instructional Package is capable of

effectively arousing, sustaining and enhancing their interest in Chemistry and especially in Electrolysis.

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