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EFFECT OF PROGRAMMED INSTRUCTION STRATEGY ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT AND ATTITUDE IN QUALITATIVE INORGANIC ANALYSIS IN OYO METROPOLIS

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Abstract

The attitude and academic achievement of secondary school students toward practical Chemistry, most especially qualitative inorganic analysis, are critical to fostering scientific literacy and preparing students for further studies in science-related fields. However, evidence from recent studies and reports indicates a persistent decline in students' attitude and achievement in practical Chemistry, particularly in areas that require higher-order thinking and problem-solving skills such as qualitative inorganic analysis. This problem was [redacted] mostly attributed to mode of instruction. Hence, this research focused on the effect of programmed instruction strategy on secondary schools students' attitude and academic achievement in qualitative inorganic analysis in Oyo Metropolis. This study adopted a 3x2 factorial quasi-experimental design with pretest, posttest, non randomized control group and non- equivalent intact

Keywords: Programmed Instruction Strategy, Academic Achievement, Attitude Qualitative Inorganic Analysis, Improvised Salts

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groups. The population of the study was two thousand six hundred and thirty-nine {2639} SS II students in Oyo Educational Zone of Oyo State. One hundred and forty-seven {147} participants were selected from six schools for this study using multistage sampling procedure and intact classes. The study employed the use of improvised materials which are grinded dried unripe plantain peels, grinded dried green cocoyam leaves and limestone ore as salts. Test of Concept of Qualitative Inorganic Analysis {TCQIA}{KR20= O.85} and Attitude to Qualitative Inorganic Analysis Questionnaire {AQIAQ}{Cronbach Alpha = 0.81} were used for data collection. Two hypotheses formulated at 0.05 level of significance and tested using Analysis of Covariance (ANCOVA) was used for data analysis. The findings of the study revealed no significant main effect of treatment on student's attitude to qualitative inorganic analysis {$F_{\{2,140\}}$= 0.1, p > 0.05}. }. It can also be concluded from the study that programmed instruction strategy significantly enhanced academic achievement in qualitative inorganic analysis. It was recommended that Chemistry teachers should be trained on the use of programmed instruction strategy and encouraged them to be using it for classroom instruction.

Introduction

The overall of what a student is capable of learning in particular subject content in a given period of time can be referred to as academic achievement. It can also be regarded as the totality of information and skills acquired by individual through education or experience {Gyuse, 2010}. The display of knowledge attained or skill developed in school subjects designed by test and examination scores or marks as ascribed by the subject teacher is the academic achievement acquired by the students, which is the knowledge attaining ability of degree of competence in school subjects usually measured by test and examination scores, expressed in a grade according to learners' performance { Obeka, Bichi & Yusuff, 2012] However, Tanwar {2020} defined academic achievement as the outcome of a standardized test or examination used to measure the level of developed skill or knowledge in students.. This helps in determining the level of instruction for which a student is prepared. If the score of the achievement test is high, it connotes mastery of the grade -level, hence such

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student is ripe for higher instructions. Also, if the achievement test score is low, this calls for repetition or remediation { Tanwar, 2020]

Chemistry can be defined as the properties of matter and their related energies. The life processes of all living things revolve around chemical changes and many of these activities centre on the study of Chemistry {Gordon & Cox, 2024}. Ojokuku {2023} defined qualitative analysis is an aspect of practical chemistry that deals with the identification of a substance, which includes determining what chemical elements that are present in the sample tested, what ions, functional groups or molecules are in its composition. Qualitative analysis helps students to identify substances like anions, cations, gases and functional groups·

The two major types of instructional materials in Chemistry teaching are conventional (standard) instructional materials and improvised instructional materials. The conventional or standard materials are imported or factory made laboratory equipment and reagents for teaching Chemistry. They use the word, standard for them because they are all conditions friendly and their purposes when used are the same. Examples are laboratory chemicals, laboratory glassware, Bunsen burners, etcetera. Standard laboratory salts are chemical materials (imported or factory made) use in qualitative inorganic analysis. Examples are KNO_3, $CuSO_4$, K_2SO_4, $(NH_4)_2SO_4$, KCl, $CaCL_2$, etcetera. Earlier study confirmed unripe plantain peels ashes contain K_2CO_3, KNO_3, KCl, $CaCO_3$, $Ca(NO_3)_2$, CaO among other compounds which are some of the metallic ions or radicals determined by qualitative inorganic analysis {Usoro, 2008]. Cocoyam leaves contain minerals such as Na, K, Ca, Mg, Fe and Mn [Adesina, 2013}.. Available study earlier conducted show limestone ore contain metallic ion concentration

Another strategy that can be adopted in teaching science is improvisation of materials sourced from one immediate environment or designed by the teacher, this may also include collaboration with the students) or with the help of local personnel to enhance instruction [Adesina, 2013}. Improvisation refers to sourcing and using relevant materials for teaching and learning processes. Effective improvisation in Chemistry, demands a good knowledge of subject matter and excellent understanding of the laws of nature. One of such improvised materials is an organic material synthesized from living things or produced without the use of artificial material [Adesina, 2013}. One of such organic material that is used in a chemical reaction is known as a reagent. It usually implies a substance that is

added to bring about a chemical change. Hence, organic reagents are improvised chemical reagents used in the Chemistry laboratory too bring about a chemical change when added to a system or added to see if a reaction will occur. For instance, a crushed grape fruit that is allowed to ferment for two days is an organic reagent for production of ethanol. Organic reagents, highly germane in modern methods of analysis, are from living things- plants and animals. Examples include olive oil, palm oil, dyes, flowers, fruits, palm wine, animal fats and skin [Adesina, 2013}.

Attitude can be viewed as structuring of beliefs, behavioural tendencies and feelings towards socially important events, groups, objects or symbols [Maio & Haddock, 2010}. These are physiological orientations developed as a result of individual's experience which influences a person's world view to issues, objects, people and how to respond to them either positively, negatively, favourably or unfavourably [Akinwande, 2022]. Attitudes are positive or negative dispositions of an individual, group of individuals, in relation to particular situation which influences individual choice of action and responses to challenges. Ocak, Dogruel & Tepe [2021] expressed attitude is an inbuilt state of a man that guides the choice of personal action made by such individual. An attitude can also be expressed as a person's values which emanates from the dictate of the environment, now or in the past acting upon the personality of such individual. Hence it can be deduced that attitude is learned by an individual and it is also emotional representations of one's personality. Attitude can be determined by carefully accepting or rejecting opinions. It is the way of feeling or emotional gesture towards something, or event or a situation [Kurniawan, Astalini,. Darmaji & Melsayanti ,2019} Attitude can also be expressed in action or words which shows one's reaction in diverse ways towards something or a given situation.

The conceptual basis of programmed instruction strategy rests on the theory interactionist orientation { symbolic interactionism, role theories , and theories of the reference group}which was designed in the 1930s. The principle of programmed instruction strategy originated in the United States of America {USA]. The first teaching machine was invented in 1927 by Pressey.The machine was a roll of paper in a box with an opening to read a text and write answers. It was in the 1950s that B. F. Skinner of Harvard University developed linear programming. According to Skinner, the learner's behavior is shaped by the

programme and he follows the S-R-R {stimulus-response-reinforcement} model. Crowder in 1959 criticized Skinner's work, hence he invented branching type of programmed instruction {Sadykov, Kokibisova, &. Minayeva, 2023].

The programmed instruction strategy is now in the realm of sustainable development of the educational process, one of the most recent contemporary teaching method, which is anchored by the educational experience in which the programmed units known as frame take the place of teaching. Hence they lead individual learner through a certain pool of planned, organized and followed-up behavioural styles. This will enable each learner to possess a desired method. This implies that the student will learn what he intended to learn via the frame. Programmed instructional strategy is one in which each learner solely interacts with the educational programme or the educational materials. Then he will move at his own pace of learning from one stage to another, after he must have mastered the previous stage before moving to the next one.

This trend will continue until educational objectives are achieved [Moreen & Nezar, 2023}. .

Statement of the Problem

The attitude and academic achievement of secondary school students toward practical Chemistry, most especially qualitative inorganic analysis, are critical to fostering scientific literacy and preparing students for further studies in science-related fields. However, evidence from recent studies and reports indicates a persistent decline in students' attitude and achievement in practical Chemistry, particularly in areas that require higher-order thinking and problem-solving skills such as qualitative inorganic analysis. The West African Examinations Council (WAEC) Chief Examiners report recommended that the candidates should improve on their qualitative inorganic analysis skill. Conventional teaching method which often emphasize rote learning, have been shown, most times to be insufficient in addressing these issues. Emerging instructional strategy, such as the Programmed Instruction Strategy (PIS) has demonstrated potential in enhancing students' engagement, understanding, and application of Chemistry concepts. Programmed Instruction Strategy, allows students to progress at their own pace. Despite the promising nature of this instructional method, there is limited research on its comparative effects on students' attitude and academic

achievement in qualitative inorganic analysis. Hence, this study, seeks to address the gap in literature by examining the effect of
Programmed Instruction Strategy on secondary school students' attitudes and academic achievement in qualitative inorganic analysis in Oyo Metropolis.

Objectives of the Study

The objectives of the study are to:

i. examine the effect of programmed instruction strategy and conventional method of teaching on attitude of Chemistry students to qualitative inorganic analysis in Oyo Metropolis;
ii. investigate the effect of programmed instruction strategy and conventional method on academic achievement of Chemistry students in qualitative inorganic analysis in Oyo Metropolis;

Hypotheses

To guide the study, the following null hypotheses were formulated:

Ho_1: There will be no significant main effect of treatment on students' attitude to qualitative inorganic analysis Oyo Metropolis.

H02: There will be no significant main effect of treatment on students' academic achievement in qualitative inorganic analysis Oyo Metropolis.

Methodology

The research design of the study was a quasi- experimental design of 2x2 factorial matrix. It focused on treatment at two levels, experimental group and control group. Programmed instruction strategy and conventional method of teaching were independent variables. The experimental group was those taught using programmed instruction strategy while the control group was those taught using conventional method. The dependent variables are academic achievement and attitude. The population of this study were all the two thousand, six hundred and thirty-nine (2639) senior secondary ll students in Oyo Metropolis which comprises of Afijio, Atiba, Oyo East and Oyo West Local Government Areas of Oyo State, Nigeria. The required number of participants for this study was selected using multistage sampling procedure. Purposive sampling technique was used to select schools from the targeted population using these criteria. (1). Schools that have

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Chemistry teachers with at least five (5) years experience of being Examiner to external examinations bodies such as National Examinations Council [NECO] and West African Examinations Council [WAEC] . (2). Schools that have standard Chemistry laboratory. (3). Schools that have laboratory assistants. [4]. Schools that have been in existence for not less than 30 years. Two local government areas in Oyo Educational Zone of Oyo State were selected by balloting. Four (4) public co-educational secondary schools were selected by balloting, two (2) schools each from a local government area. Selected schools from Afijio Local Governmet Area are Akinmorin Grammar School, Akinmorin and Fiditi Grammar School with each of them having 24 and 25 respectively as the number of Chemistry students in Senior Secondary School ll. In Oyo East Local Government Area, the selected schools are Abiodun Atiba Memorial Institute, Kosobo, Oyo and Durbar Grammar School,Durbar, Oyo with each of them respectively having 34 and, 16 Chemistry students in Senior Secondary School ll. Each school was randomly assigned to experimental group (R_1) and control group (R_2)

Research Instruments

1. **Test of Concepts of Qualitative Inorganic Analysis (TCQIA)**
   Test of concepts of qualitative inorganic analysis has two sections. Section A consists of demographic data of the participants while section B consist of twenty five multiple choice questions. The twenty five multiple choice questions consist of four distractors and one correct option; and lettered A-E. The instrument was scored manually; one mark was awarded for each correct answer, while zero was awarded for wrong answer. The total obtainable marks was twenty five.
2. **Attitude to Qualitative Inorganic Analysis Questionnaire (AQIAQ)**
   The instrument was developed by the researcher to elicit information on student's attitude to qualitative inorganic analysis. The instrument has two sections. The first section comprises of the biographic data of the participant, while the second section deals with the attitude of students to learning of qualitative inorganic analysis. The design of section A allowed information about the participant's age, sex, class and school. AQIAQ is constructed on four- point Likert Scale response format; Very untrue of me – 1, not true of me – 2, true of me – 3, VTo very true of me – 4. The response format will be reversed for negative

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items with; Very untrue of me – 4, not true of me – 3, true of me – 2, Very true of me – 1

Validity and Reliability of Research Instruments

Cronbach Alpha formula was used to determine the reliability index of the items. The reliability coefficient of the Attitude to Qualitative Inorganic Analysis Questionnaire {AQIAQ} is 0.81. To validate Test of Concept of Qualitative Inorganic Analysis {TCQIA}, the data collected from the pilot study was used to determine its reliability coefficient using Kuder
Richardson of KR20=0.85

Method of Data Collection| Pre – Experimental Activities and General Procedure

The researcher visited the four (4) selected schools to sought permission from the authority of those schools and duly inform them about the research. The experiment covered a period of eight (8) weeks. Chemistry teachers in each school served as research assistant. Three (3) weeks was used for their training and the production of the improvised salts .The researcher briefed the research assistants on the making of the improvised materials as salts. He carried out the experiments using the improvised salts in the presence of each research assistant. In the presence of the researcher, each research assistant used the improvised salts to teach selected SS3 students that are not part of the population. The improvised organic salts are grinded dried unripe plantain peels, grinded dried green cocoyam leaves and limestone ore.

Table 1

Instruction Strategy (PIS), and Conventional Method (CM)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1226.208a	6	204.368	5.005	0	0.177
Intercept	5187.408	1	5187.408	127.035	0	0.476
Pre-attitude	1049.549	1	1049.549	25.703	0	0.155
Treatment	8.153	2	4.076	0.1	0.905	0.001
Error	5716.812	140	40.834			
Total	520067	147				
Corrected Total	6943.02	146				

a R Squared = .177 (Adjusted R Squared = .141)

Source: Field Survey Report, 2024

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Table 1 shows the summary of analysis of covariance (ANCOVA) of student's attitude in qualitative inorganic analysis by Treatment (PIS and CM) . The table reveals that after adjusting for the covariance, (pre- student's attitude in qualitative inorganic analysis), the effect of treatment on student's attitude in qualitative inorganic analysis was not statistically significant,
$F_{(2,140)} = 0.1, p > 0.05$. Consequently, the null hypothesis which stated that there was no significant main effect of treatment on student's attitude in qualitative inorganic analysis was not rejected

Hypothesis 1(b): There is no significant main effect of Treatment on Students' Achievement in qualitative inorganic analysis. This hypothesis was tested at .05 significant level using Analysis of Covariance (ANCOVA)

Table .2: Summary of Analysis of Covariance (ANCOVA) of Students' Achievement in qualitative inorganic analysis by Treatment (PIS and CM)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1249.726a	6	208.288	17.253	0	0.425
Intercept	753.145	1	753.145	62.385	0	0.308
Pretest	8.788	1	8.788	0.728	0.395	0.005
Treatment	779.154	2	389.577	32.27	0	0.316
Error	1690.152	140	12.073			
Total	15393	147				
Corrected Total	2939.878	146				

a R Squared = .425 (Adjusted R Squared = .400)

Source: Field Survey Report, 2024

Table 2 shows the summary of analysis of covariance (ANCOVA) of student's achievement in qualitative inorganic analysis by Treatment (PIS and CM). The table reveals that after adjusting for the covariance, (pre- student's achievement in qualitative inorganic analysis), the effect of treatment on student's achievement in qualitative inorganic analysis was statistically significant, $F_{(2,140)} = 32.27, p < 0.05$. Consequently, the null hypothesis which stated that there was no significant main effect of treatment on student's achievement in qualitative inorganic analysis was rejected. The table further shows that the partial Eta square, (η^2)was 0.32, which was considered to be moderate effect size according to Cohen (1988).

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Discussion of Results

Main Effect of Treatment on Students' Attitude in Qualitative Inorganic Analysis

There was no significant main effect of treatment { Programmed Instruction Strategy, PIS and Conventional Method CM} on student's attitude in qualitative inorganic analysis as shown by the results of the findings. Though there were different treatment procedures amongst the groups, yet the results of the findings showed no significant main effect. The outcome of this study corroborates a study that worked on Effect of Problem Solving Approach on Academic Achievement and Attitude of Basic Science Students with Varied Abilities in Oyo Metropolis which revealed that ability levels { low, medium and high} has no significant effect on student's attitude to Basic Science {Ojo, 2021}. In the same vein, the finding is also in agreement with a study conducted by Apara & Yoloye {2019} that discovered that after intervention, no statistically significant main effect on student's attitude in Chemistry .This finding was also at variance with a study on the Effect of Cognitive Entry Features on Student's Affective Achievement in Bearing in Mathematics. A significant effect of treatment on the students attitude was revealed { Obaitan & Adeleke, 2007}

Main Effect of Treatment on Students' Achievement in Qualitative Inorganic Analysis

The main effect of programmed instruction strategy and conventional method on student's post test scores in qualitative inorganic analysis was revealed to be statistically significant after adjusting to the covariate {{pretest score in qualitative inorganic analysis}. The achievement of students in each group differ from one another with students in Programmed Instruction Strategy using improvised salts group having the best achievement, next in this ranking is Conventional Method using improvised salts group . This result is in accordance with a research conducted which opined positive learning outcome and retention in Business Studies when taught using Programmed Instruction Teaching Method than those taught Business Studies using conventional teaching method Umoru & Adeleke, 2019}.

Conclusion

The findings of this study have revealed that programmed instruction strategy has significantly enhanced academic achievement in qualitative inorganic analysis.

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Recommendations

1. Chemistry teachers should be trained on the use of programmed instruction strategy and encouraged them to be using it for classroom instruction.
2. Workshops and seminars should be organized for serving Chemistry teachers on improvisation of important instructional materials.

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