



EFFECTIVENESS OF 5ES CONSTRUCTIVIST INSTRUCTIONAL MODEL ON STUDENTS' PERFORMANCE AND RETENTION IN CHEMISTRY IN SECONDARY SCHOOLS IN EKITI-STATE, NIGERIA.

BY

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Abstract

This study investigated the effectiveness of 5Es Constructivist instructional Model on Senior Secondary School Students' Academic Performance and Retention in Chemistry in Ekiti State, Nigeria. Specifically, this study examined the effectiveness of 5Es constructivist instructional model on academic performance of students taught Chemistry before and after treatment as well as on their retention. The study adopted quasi experimental design. The population comprised 12690 Chemistry students in all year two of 202 public senior secondary schools in Ekiti State. The sample of 139 was selected through multi-stage sampling procedure. An instrument tagged "Chemistry Academic Performance Test (CAPT) was used for data collection. Inferential statistics of t-test was used to test hypotheses generated. All the hypotheses were tested at 0.05 level of significant. The findings revealed that the students taught using 5Es constructivist instructional model performed better ($p < 0.05$) and retained more knowledge ($p < 0.05$) than those taught using Conventional method. The study concluded that 5Es constructivist instructional model improved academic performance and aid better retention of students towards Chemistry when compared with conventional method. The study recommends the adoption of 5Es constructivist instructional model in teaching Chemistry.

Keywords: 5Es (Engagement, Exploration, Explanation, Elaboration, Evaluation) Constructivist Instructional Model, Academic performance, Retention, Chemistry

Introduction

Education is the process of acquiring knowledge and skills which serves as light to the

paths of global development, the best antidote to solve global challenges. Education is the field



of study that deals mainly with the methods of teaching and learning in school (Meriam, 2024).

Skills acquisition and activities from various scholars like Newton, Faraday, Avogadro and some others emanated various concepts that made up of the studies in science. To acquire the knowledge of science, one requires science education. Science education is a field of study concerned with producing scientific literate learners in a society. Science education is the subject thought as elementary science in primary school level, as basic science in junior secondary school level while at the senior secondary level, it is taught as Biology, Physics and Chemistry.

The relevance of Chemistry as a requirement for technological advancement of a nation cannot be underrated. It has contributed tremendously in health sector, agricultural sector and industry. Chemistry is one of the three main branches of science, it is the subject that is popularly called “the nucleus of science”. It is so called because it bridges other natural sciences. Chemistry is the study of composition, structure (defined as elements and compounds); and properties of matter, the changes they undergo under various conditions of temperature and pressure, and the energy that is released or absorbed during the process (Mellyn and Alan, 2024). Faley (2024) also described Chemistry as the branch of science that deals with the identification of substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine and change, and the use of these processes to form new substances. All substances, either naturally occurring or artificially produced, consist of species of atoms or elements. Therefore, Chemistry can

be defined as the study of matter, properties, how and why matter combined or separate to form new substances. Matter is the name given to everything that can be touched, seen, felt or smelled. Chemistry is essential in various fields and sectors as in agriculture, health, industries and others. It is a prerequisite for students that will be admitted into any course in science and technological fields in higher institutions of learning.

Despite the usefulness of Chemistry, there are various challenges that are facing the teaching and learning of the subject. Over the years experts have been working on the challenges in Chemistry. Many instructors and learners consider Chemistry as difficult to teach and to study (Okebukola, 2020). Some also believe that Chemistry has a reputation as a hard and difficult science to master (Anne, 2016). Chemistry is often regarded as a difficult subject; an observation which often repels learners from learning Chemistry (Soyibo and Okelola, 2020). Report from several researchers reveals that students' performance in senior secondary schools certificate examination (S.S.C.E) conducted by WAEC and NECO in Chemistry is persistently poor (Ojukwu, 2016; Adeniyi, 2020). Poor academic performance of the students in internal and external examinations needs urgent attention, for it was reported that performance in internal examination in Chemistry is as bad as 25% pass (Adeyemi, 2020), so also 22% pass (Nnoli, 2022).

Poor performance of students in Chemistry has been a major concern in the field. Agoro (2018) opined that inefficient method of instruction brings poor performance as some students memorize and struggle to pass the examination while some may not be able to make the required passmark meant



for admission. The country's level of educational system is not equipping the beneficiaries with the needed skills necessary for economic, scientific and technological development (Adebayo, 2020; Oyinloye, 2020; Nnoli, 2022). This is also supported by Adeniyi, (2020) who stated that poor academic performance of students in internal and external examinations is a reflection of the problems and challenges facing the economy of Nigeria today.

Hardly do students apply for Chemistry Education while seeking admission into higher education of learning due to lack of interest in the subject and because of the way it is taught. Majority of those studying Chemistry Education in the University are there not because it was their original plan but because they could not be admitted into the courses of their choice and are tired of sitting at home, this may be one of the reasons while some of Nigerian undergraduates students in Chemistry perceived higher percentage of Chemistry concepts (64.3%) as difficult. This is so because the problem is fundamental. Again some of those who graduated as Chemistry Educators had diverted to the industries and other sectors for employment. The consequence of this is that there are not sufficient qualified teachers to teach the subject thus making the school administrators to make use of teachers in other science-related disciplines to teach Chemistry in majority of the secondary schools. If science is poorly taught and badly learnt, it could burden the mind of the learner with dead information and even degenerate into a new superstition.

It is widely noted that one of the goals of science teaching is for science students to acquire knowledge as well as understanding, but some teachers often disseminate instructions as they were taught in one or two decades ago which make some

learners regard scientific knowledge as alien to them, and just to absorb and memorize the scientific facts in order to pass examination. Evidence from several researchers suggested that oral presentation to large group of passive students contribute very little knowledge to real learning. Jegede (2023) opines that science needs to be activity laden. Aparna (2015) observed that cognitive theory on science has moved teaching and learning of science from telling story and dispensing of knowledge (or what one might term "absolute truth) to the problem solving phenomenon. Some of the methods of teaching science as stated by Oyediji and Akinwumi (2019) include: teacher-centered methods (which include: traditional method, lecture method and demonstration method) and Heuristic method. Heuristic method is a method in which a student is being put in the position, to discover the principles of science. Heuristic method can be otherwise regarded as student-centered method which enriched with inquiry and discovery based methods, into which 5Es constructivist instructional model falls. It is a problem-solving technique that can be used for teaching science effectively. Since education is being regarded as a field of study that deals mainly with methods of teaching and learning in school (Meriam, 2024), there is a need to consider the methods of teaching that will make effective learning to take place.

In teaching towards understanding of major concepts in Chemistry and achieving conceptual change in the students learning, it is first necessary to understand students' prior knowledge, examine it, identify confusion and then provide opportunities for old and new ideas to come into contact in a meaningful way. In teaching towards conceptual change, it is counterproductive to cover more materials and present new ideas



without engaging students in their own meta-cognitive analysis (Oyedemi and Akinwumi, 2019). So, inquiry or discovery based method can be seen as the strategy for teaching towards conceptual change. Inquiry based method engages students in questioning of one's preconceptions and characteristics of both conceptual change and scientific habits of mind (Jegede and Omotayo, 2016). Discovery method tends to focus more on the product of learning, where students discover a specific content of a concept. The 5Es constructivist instructional model is an inquiry-based approach that incorporates the elements of the discovery method as hybrid and utilizes the strengths of both approaches. It is 21st century instructional model.

The 5Es constructivist instructional model is about how learners' learn to construct ideas or knowledge in their own understanding by relating their prior knowledge with the new instruction presented. It is an interlinked progressive phases of learning to construct individual knowledge in group form through their experiences. It is a student-centered approach where students are involved in experiencing, questioning or investigating. Bybee (2019) asserted that 5Es constructivist based approach allows students and teachers to experience related activities to use and build on prior experiences and knowledge of the student, in order to access their understanding of the new concept. The 5Es constructivist instructional model motivates the engagement of the students in group by making them active participants in the classroom. This approach requires students to do beyond memorization of facts.

Several researchers have shown that using conventional methods in teaching Chemistry have limitations in promoting understanding and retention

of concepts (Lawson, and Renner, 2015; Tara, Kishbaugh, and Stephen, 2018; Adeyemi, et al, 2022; Tamene, and Astrat, 2023). Constructivist learning theory suggests that learners build new knowledge based on prior experience and knowledge. The 5Es constructivist instructional model involves five interlinked phases. They are: engagement; exploration; explanation; elaboration and evaluation. These provide a carefully planned sequence of instruction that places students at the center of learning (Bybee, 2023).

1. Engagement phase is the first stage in this model whereby students will be introduced to new topic by asking question on the topic to be taught (in reference to Jerome's Brunner's theory who believes in knowledge moving from complex to simple) and observe their current understanding towards the concept. The teacher asks open-ended question that will subject the students to critical thinking that will emanate problem solving skill within their social group, this increases students' motivation to learning. The question may be on the topic to be presented or any related instructional material that is provided to enhance learning of the new topic. The question is meant to increase the students' curiosity towards the new lesson.
2. Exploration phase is the second stage that allows the students to interact and work together as a group to investigate the question; objects or situation, through their learning experience (otherwise known as prior knowledge), the students will be subjected to critical thinking through the question being asked from them to explore from their prior knowledge which leads to problem solving skill to make observations. Individual prior



knowledge will be directly related to others within their social group. This activity helps the students to acquire common experiences to give feedback to their teacher on the question being asked from them. They construct their own understanding through active learning.

3. Explanation phase is the third stage where the teacher will ask the students to give their response and observations in the exploration stage on the question being asked from them. The teacher will now present the new concept starting from the students' observations in the exploration stage and encourage the students to compare the new concept with their own observation constructed at the exploration stage through their prior knowledge. The teacher will correct their misconceptions and add other essential contents. This will aid accommodation and assimilation of the new concept in the learners. Various instructional materials can as well be used to aid the study.
4. Elaboration phase is the fourth stage whereby the teacher will encourage the students to apply what they have learnt to solve new problem. It will be in form of giving the students question to solve on the new concept. Students will apply the knowledge acquired from their teacher (more knowledgeable person as beliefs by Lev. Vygotsky's theory) through accommodation and assimilation of the knowledge into the learners' prior knowledge, to solve the given question. Knowledge acquired by individual students (students' prior knowledge with the new knowledge acquired) will be directly related to others within their social interaction to enhance common knowledge for

making observations and respond to the question's given on the new concept.

5. Evaluation phase is the fifth and last stage of the 5Es constructivist instructional model. It is the stage of reflection of learning outcomes whereby students will be assessed individually. This is where the summative assessment of the students on the concept presented will be determined. It may be in form of classwork, assignment, test or examination.

For effective learning to take place, there must be active engagement and opportunity for practice and application. The learning process is facilitated by the skilled teacher who engages students in thinking, questioning, investigating, and experimentation and so on. The teacher should have good knowledge of the subject matter with suitable teaching methods for effective delivery of the concept. Constructivism beliefs in building knowledge and claims that learning remains subjective by the cognitive organ of the learner and is not transferred from teacher to learner. Also, it makes learners to think, be active and interact positively during the process of learning.

Academic performance is the result obtained from a specific learning task which can be measured by grade, score or accomplishment. It indicates student mastery of subject matter, ability to put knowledge into application and level of engagement or effort in a study (Candia, et. al, 2022). It develops knowledge, critical thinking abilities and skills. It identifies areas of improvement in the learners. The use of innovative teaching strategy is needed to enhance performance of students towards the learning of Chemistry. Academic performance can be measured in academic performance test, creativity or innovation and personal growth. Academic performance focus on what



learners will know, understand and be able to do at the completion of a learning experience. It gives direction towards specific information about what students has done after a specific task. Teacher needs to work on improvement of academic performance of students by be a facilitator of learning process. The teacher must focus on the idea that students should be actively involved in the process of teaching and learning. There are various learning styles in learners. Learning style is a reflection of inherited character or the one that developed through exposure, or influence of immediate environment to form personal character of the individual student in which knowledge is retained. Individual students have their own way to learn best likewise, they have ability to understand and absorb knowledge at different paces.

Some are fast learners, some are moderate learners while some are slow learners, while some are very slow learners. Learners can also be grouped according to their various learning styles; visual learners, auditory learners, kinesthetic learners (hands-on-experiment practices), reading or writing learners, logical learners (logic pattern and problem solving), solitary learners and social learners. Social learners learn through social interactions, collaborative activities and group discussions. Adegbite (2020) defined cognitive style as a psychological disposition which shows how individual is inclined to think, learn and process information. Individual students have their different ways of perceiving and analyzing information. 5Es constructivist instructional model utilize this individual ways of perceiving information from individual's prior knowledge to achieve effective learning. Cecilia, et, al. (2024) observed that students taught using 5Es

instructional strategy outperformed those taught with conventional methods. Opeyemi, (2020) also in his submission observed that students taught with 5Es instructional strategy perform better than those taught using lecture method.

Retention is an important aspect of cognitive skills that allows learner to have access and retained information into memory, thereby helps learner to utilize the acquired information over time appropriately. It is the ability to store, recall and retain information, knowledge or skills over time (Adegoke, 2022). It connects information from short-term memory to long-term memory in order to access future recall. This means retention helps individuals to recall and build upon prior knowledge and skills, as well as to acquire more knowledge and skills into memory. Theory of constructivism based teaching and learning on individuals' prior knowledge, concepts and ideas that act as a starting point from which to comprehend, inculcate and display new knowledge (Lawson, 2018). Prior knowledge of a learner is retained in retention phase of learner's memory. 5Es constructivist instructional model enhance effective retention. Adeyemi, et al, (2022) observed that 5Es approach improved students' retention of Chemistry concepts.

Effective method of teaching may enhances retention by promoting active learning, curiosity, critical thinking, problem solving and some other skills in learners. These can be revealed in the academics performance of the learners. Some authors revealed that the low performance in Chemistry is attributed to ineffective instructional techniques and teaching aids (Soyibo and Okelola, 2020, Okebukola, 2020). So, it is important for a teacher to use appropriate instructional method in order to achieve the learning goals. Inculcating a teaching strategy that

encourages students to be active in the classroom may assist in achieving learning goals. So, the application of 5Es instructional model can as well improve the goals of learning in Chemistry.

Purpose of the Study

The main purpose of the study was to investigate the effectiveness of 5Es constructivist instructional model on senior secondary schools students' academic performance and retention in Chemistry in Ekiti State, Nigeria.

Specifically, this study purported to:

- i. compare the academic performance of students taught using the 5Es constructivist instructional model with those taught using conventional method in Chemistry;
- ii. determine the extent to which 5Es constructivist instructional model influences retention of the students in Chemistry;

Research Hypotheses

Experimental Group: O_1 X_1 O_2 , O_{R1}

Control Group: O_3 X_c O_4 , O_{R2}

Where

O_1 , O_3 = Pre-test observation (Academic Performance before treatment)

O_2 , O_4 = Post-test observation (Academic Performance after treatment)

O_{R1} , O_{R2} = Retention observation

X_1 - Treatment via 5Es constructivist instructional model

X_c - Treatment via Conventional method

The population for this study consisted of 12,690 Chemistry students in year two of all the 202 public senior secondary schools in all the 16 Local Government Areas in Ekiti State, (Source: Department of Planning, Research and Statistics, Ekiti State Ministry of Education, 2024. The sample consisted of 139 Chemistry students in public secondary schools year two, Ekiti

The following null hypotheses were generated for this study.

1. There is no significant difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and conventional method, before treatment.
2. There is no significant difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and conventional method after treatment.
3. There is no significant difference in the retention of students taught Chemistry using 5Es constructivist instructional model and conventional method.

METHODOLOGY

This study adopted a pretest, posttest, control group quasi-experimental design (one experimental group and one control group). The paradigm of the design is as shown below:

State, Nigeria. The sample was selected using multi-stage sampling procedure. Chemistry Students' Academic Performance Test (CAPT) was the instrument used to collect data for academic performance of students' taught in this study. The CAPT consisted of two sections; A and B. Section A elicited information about the bio-data of the respondents such as the name of school and class. Section B was consisted of 20 multi-choice items of five options (A-E) from



which the respondents are expected to choose the options they deemed correct. The duration of CAPT was 20 minutes. The instrument was given to the respondents in both groups as pretest and post-test. Chemistry Academics Performance Test (CAPT) was re-administered (as Retention Test) after two weeks of post-test to measure students' retention in Chemistry.

The face and contents validity of the instrument was ensured by two teachers who were Senior Secondary School Certificate Examinations' examiners in Chemistry, an expert in Science Education (Chemistry Option) as well as Test and Measurement expert in the Faculty of Education, Ekiti State University. The reliability of the instrument was established by finding the internal consistency of the instrument. CAPT was administered on 40 science students in S.S.II, outside the sample used for the study. The scores obtained from the Performance test was analyzed using Pearson's Product Moment Correlation Analysis, from which reliability

coefficient of 0.86 was obtained for the CAPT which adjudged the instrument suitable for this study.

After selecting the subjects for the study, the researcher assigned the experimental and control groups using simple random sampling technique. The experimental procedures for this study were carried out in three stages: pre-treatment stage, treatment stage and post-treatment stage. Eight weeks were used for the study: pre-test: one week, treatment: four weeks, post-test: one week, conducted on both experimental and control groups. After two weeks of the post-test, there was retention test conducted on the respondents. Each of the questions in the CAPT was scored one mark and the total mark is twenty (20).

Results

Table 1 below shows the t-test analysis on the difference in the academic performance of Students' taught Chemistry with 5Es constructivist instructional model and conventional method before treatment.

Table 1: t-test analysis on the pretest scores of experimental and control groups.

*p>0.05

The result presented in table 1 showed that p (0.06) > (0.05), which means the p

Groups	N	Mean	SD	Df	t	P
5Es Constructivist Instructional Model	70	4.09	1.39	137	0.25	0.06
Conventional Model	69	3.98	1.37			

value is 0.06 which is greater than 0.05, the null hypothesis is thereby not rejected, implying that there was no significant difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and those taught with conventional method before treatment. This implies that the

students in both groups were homogeneous at the commencement of this study.

Table 2 below shows the t-test analysis on the difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and conventional method after treatment.



Table 2: t-test analysis on the posttest scores of experimental and control groups.

Group	N	Mean	SD	df	t	P
5Es Constructivist Instructional model	70	13.17	1.65	137	13.79	0.00
Conventional method	69	9.52	1.46			

*p < 0.05

The result presented in table 2 showed that $p(0.00) < (0.05)$, the p-value is 0.00 which is less than 0.05 level of significance, the null hypothesis is thereby rejected, implying that there was a significant difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and conventional method after treatment. This implies that the 5Es constructivist instructional

model is more effective than the conventional method to teach Chemistry.

Table 3 below shows the t-test analysis of the difference in retention of students taught Chemistry using 5Es constructivist instructional model and conventional method.

Table3: t-test analysis on retention of students taught Chemistry with 5Es constructivist instructional model and conventional method.

Groups	N	Mean	SD	df	t	P
5Es Constructivist Instructional Model	70	12.21	1.78	137	15.17	0.00
Conventional Method	69	8.10	1.39			

*p<0.05

The result presented in Table 3 showed that $p(0.00) < (0.05)$ the p-value (0.00) is less than 0.05 level of significance, the null hypothesis is thereby rejected implying that there was a significant difference in the retention of students taught Chemistry using 5Es constructivist instructional model and those taught with conventional method. Students taught Chemistry with 5Es constructivist instructional model had a better retention of the concepts taught than those taught with the conventional method. The implication of this is that, the 5Es constructivist instructional model is more effective in teaching Chemistry than the conventional method.

Discussion

The findings of the study revealed no significant difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and conventional method before treatment which implied the homogeneity of students in both groups at the commencement of the study. The finding further revealed a significant difference in the academic performance of students taught Chemistry with 5Es constructivist instructional model and those taught with conventional method, with the students taught with 5Es constructivist instructional model performing better than those taught with conventional method. This agreed with the study of Cecilia et al. (2024) that students



taught with 5Es constructivist instructional strategy performed significantly better than those taught with conventional method. It is also in line with the findings of Opeyemi (2020) who revealed that students taught with 5Es constructivist instructional strategy performed better than those taught using lecture method. The finding also aligns with that of Ednah, Olokoba and Borishade (2023) who revealed that the 5Es Constructivist teaching approach was found to be more effective in teaching Chemistry.

The findings also revealed a significant difference in the retention of students taught Chemistry using 5Es constructivist instructional model and those taught with conventional method after treatment with students taught with 5Es constructivist instructional model having a better retention of the Chemistry concepts taught than those taught with conventional method. This implied that 5Es constructivist instructional model aids retention of students taught Chemistry better than those taught with conventional method. This finding agreed with the finding of Adeyemi, et al. (2022) that 5Es constructivist instructional model showed a significant improvement in students' retention on Chemistry concepts. It also agreed with the findings from the study of Tamene and Asrat (2023) which confirmed a significant difference in students' retention between traditional method and 5Es constructivist instructional model in favour of 5Es constructivist instructional model.

Conclusion and Recommendation

From the findings of this study, it could be concluded that the two groups (5Es constructivist instructional model and conventional method) were homogeneous before the experiment. The use of 5Es constructivist instructional model

improves academic performance and retention of students taught Chemistry better, when compared to conventional method. 5Es constructivist instructional model improved academic performance and aid better retention of students towards Chemistry when compared to conventional method.

Based on the findings of this study, it was recommended that the use of 5Es constructivist instructional model should be adopted in senior secondary schools for studying Chemistry concepts so as to improve academic performance, and retention of students to Chemistry.

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