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EFFECTS OF 5ES CONSTRUCTIVIST INSTRUCTIONAL MODEL ON SENIOR SECONDARY SCHOOL CHEMISTRY STUDENT'S ACHIEVEMENT AND INTEREST IN IUPAC NOMENCLATURE OF ALIPHATIC HYDROCARBONS IN ANKPA KOGI STATE

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ABSTRACT

This study examined the effects of 5Es constructivist instructional model on students' academic achievement and interest in IUPAC nomenclature of aliphatic hydrocarbons concept of organic chemistry. Quasi experimental design, a pretest-posttest non-equivalent was used for the study. The population of the study was 2,345 senior secondary three chemistry students for 2022/2023 academic session in Ankpa LGA, Kogi State. A sample of 157 (87males and 70 females) SSS III students from two co-educational secondary schools purposively sampled in the study area. IUPAC Nomenclature of Aliphatic Hydrocarbons Achievement Test (INAHAT) and IUPAC Nomenclature of Aliphatic Hydrocarbons Interest Inventory (INAHII) were instruments used for data collection. The instruments were validated by experts and pilot tested. A reliability coefficient of 0.97 was obtained for INAHAT using Kuder-Richardson 21 and 0.92 for INAHII using Cronbach Alpha. Descriptive statistics of mean and standard deviation were used to answer the four research questions posed while Analysis of Covariance (ANCOVA) was used to test the four research hypotheses formulated and tested at 0.05 alpha level of significance. Findings revealed that students taught IUPAC Nomenclature of Aliphatic Hydrocarbons using 5Es constructivist learning strategy performed better and expressed more interest than those taught using conventional lecture strategy. Also, it was equally revealed that male and female students exposed to 5Es constructivist instructional model achieved equally and expressed equal interest. It was concluded that 5Es constructivist instructional model improved the academic achievement and fostered interest of chemistry students. Based on these findings, it is recommended that chemistry teachers should expose their students to 5Es constructivist institutional model to promote and encourage active learning by experience among learners.

Keywords: 5Es Constructivist Instructional Model, Students' Achievement, IUPAC Nomenclature, Aliphatic hydrocarbons, Interest and Gender.

Introduction

A student's academic achievement at secondary school is usually measured by teacher-made tests or standardized tests (Kpolovie, 2014a) which in most cases are referred to as external examinations like the Senior School Certificate Examination conducted in Nigeria by the West African Examination Council (WAEC) and the National Examination Council (NECO) (Kpolovie *et al*., 2011). Because of the importance attached to achievement at the

secondary school level of education, Suleman *et al*. (2014) concluded that secondary education is the foundation stone for further studies and also for the development of a nation. In this regard, academic achievement occupies important place in education and it is one of the most popular judgment standards on total potentialities and capacities (Puhan *et al*., 2014). In this context, Joe *et al.* (2014) sees academic achievement as the observed and measured aspect of a student's mastery of skills and subject contents as measured with valid and reliable tests. Udoh (2015) equally maintained that academic achievement of students is a phenomenon that has educational, psychological and sociological connotation. In short, academic achievement is a determinant of the efficacy and efficiency of a given instruction (Kabutu *et al*., 2015). Unfortunately, it is no longer news to hear that student's academic achievement in sciences especially chemistry in Nigerian schools in both external examination and internal examination has been very poor. This situation if it remains unabated will further under develop the nation (Nja *et al*.,, 2020 and Uchegbu *et al*., 2017). Similarly, Nwankwo and Okigbo (2021); Uchegbu *et al*. (2015) reveal that only a very negligible number of students achieve well in the examinations.

Many reasons have been attributed for the observed poor academic achievement. One of the reasons, according to Igboanugo and Njoku (2015); Isa (2018) is that science students perceive organic chemistry to be abstract and difficult to learn, as such they perform relatively low in organic concept. This was also reported by Kyado *et al*. (2021) that students perceived chemistry concepts like thermodynamics, ionization, chemical kinetics, redox reactions, quantum numbers, stoichiomtry, enthalpy, mole concepts, atomicity, enantiomers, nuclear chemistry, quantitative analysis and neutralization as difficult to learn. Uchegbu *et al*.(2016) equally reported that students perceived chemistry syllabus to be too wide, too abstract and involves too many calculations. Another reason Kabutu *et al*. (2015); Igboanugo and Njoku, (2015) observed is that poor instructional strategies employed in the teaching of chemistry subject by teachers contribute to students under achievement. It has been criticized by Ahmad (2019) that, lecture is an ineffective strategy of teaching which does not yield positive result on students' academic achievement. In addition, Isa *et al*.(2020) observed that lecture strategy does not apply activity based learning to encourage students to learn real life problems based on applied knowledge.

To enhance students' academic achievement in chemistry, the student-centered learning mode of teaching strategies have been recommended by the FRN (2014) and Adesoji *et al*. (2015). In addition, Palanissamy *et al*. (2017) emphasizes that student-centered strategy inspires students to be autonomous learners, enrich them with various skills that enable them to think critically and also seen as the best strategy for meeting the individual needs of students. Palanissamy, *et al*. (2017) further stated that, the significant benefits of this strategy is that it places the teacher at the position of a facilitator, encouraging students to be active critical thinkers and also using their analytical skills in the teaching and learning of chemistry. Over the last three decades, a great number of academic publications have focused on the subject of active learning, with strong evidence to support its benefits in leading to more meaningful learning (Freeman *et al*., 2014). Research has shown that students learn more when they are

exposed to active learning strategies, which means that they are actively engaged in obtaining, sharing, discussing, creating, and applying knowledge, and when students use higher order thinking such as analysis, synthesis, reflection, and evaluation (Mueller *et al*., 2015).

The active constructivist instructional models of Atkin and Karplus learning cycle and the science curriculum improvement study learning cycle have consistently proved useful to help teachers change their conventional instructional models to more active educational models (Marfilinda & Indrawati, 2019). Among these systematic active instructional models, the 5Es constructivist instructional model, developed in 1987 by the Biological Sciences Curriculum Study (BSCS), is likely the most widespread and ubiquitous model (Bybee *et al*., 2006).This model builds on the work of other instructional models and its design is based upon sound cognitive science research (Bybee, 2015). 5Es constructivist instructional model is considered one of the most commonly used and effective cycle (Srisawasdi & Panjaburee, 2015). This model has five learning phases/stages all beginning with 'E'– engage, explore, explain, elaborate, and evaluate, and hence its name (Bybee, 2009; O'Brien (2010). Each phase has a specific function and contributes to helping the teacher provide coherent instruction and to the learner formulating a better understanding of scientific knowledge, attitudes, and skills.

According to its creators, the five phases of the 5Es constructivist instructional model are designed to facilitate the process of conceptual change (Bybee, 2015). It is seen that 5Es constructivist instructional model is especially effective in the elimination of misconceptions (Ultay & Calik, 2016). The purpose for the engage stage is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding. The explore stage tries to get students involved in the topic; providing them with a chance to build their own understanding. The explain stage provides students with an opportunity to communicate what they have learned so far and figure out what it means. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways. The last stage is the evaluation stage which is for both students and teachers to determine how much learning and understanding has taken place. In this process, the teacher acts as facilitator, supporter, and feedback provider for the students (Kong & Song, 2014). The postulation that 5Es constructivist instructional model improves students' achievement (Garba, 2020).

The results of several studies confirm that 5Es model is more efficient than teacher-centered methods of instruction. 5Es constructivist instructional model is superior compared to conventional strategies in facilitating a conceptual change in understanding scientific concepts (e.g. Boakye & Nabie, 2022; Lasaiba, 2023; Varoglu *et al*., 2023). It promotes the development of critical thinking and argumentation skills, as well as the ability to apply the knowledge in practice (Amaliyah *et al*., 2023; Ha *et al*., 2023; Vafaeikia *et al*., 2023). It also facilitates the development of inquiry skills or scientific process skills (Jeskova *et al*., 2022; Tolba & Al-Osaimi, 2023). It also improves the learning atmosphere and allows students to take over their own learning (Maxwell *et al*., 2015) and express their ideas and opinions (Bezen & Bayrak, 2020). The 5E constructivist

instructional model also has effect on long-term learning (Koyunlu Unlu & Dokme, 2022). In addition, some studies equally show that 5Es constructivist instructional model enhances students' achievement and it also favours both male and female, giving credence to the instructional model as a gender friendly and sensitive strategy (e.g. Ematum, 2018; Bunkure, 2019; Garba, 2020). Some studies show superiority of male students above those of their female counterparts in chemistry; while others show female superiority over those of their male counterparts especially when speech and memory cues are incorporated into learning experiences given that the females have more advanced verbal activities (Etiubon & Ugwu, 2018).The study on gender-related difference and academic achievements is not conclusive.

Interest is also another factor that affects students' achievements in chemistry. Oguche and Usman (2019) see interest as an aspect of affective domain which has to do with ones readiness to like or dislike something. If a student shows a higher interest in a course, this will help him to put in more time, effort and energy in learning which will in turn lead to higher or better achievement (Godpower-Echie & Ihenko, 2017). On this note, several studies show that 5Es constructivist instructional model increases students' motivation as well as their interest in studying science (e.g., Bakri & Adnan, 2021; Iscan & Seyhan, 2021; Itsarangkul Na Ayutthaya & Damrongpanit, 2022). From the foregoing background, teachers should focus on cultivating, stimulating, and fixing students' interests in chemistry, activating and maintaining students' enthusiasm for learning. Conscious efforts therefore need to be made to prepare these students with a view to capturing their interest and enhancing their achievement in sciences especially chemistry (Olatoye, 2017). It is based on the stated background that the researcher intended to find out the effects of 5Es constructivist instructional model on secondary school students' achievement and interest in IUPAC nomenclature of aliphatic hydrocarbons concept of organic chemistry in Ankpa LGA of Kogi State.

Statement of the Problem

Over the years, several conventional strategies have been extensively used by chemistry teachers to teach in senior secondary schools in Kogi State especially Ankpa LGA, but yet student's achievement in chemistry has not been satisfactory. In order to bring about improvement in chemistry achievement among secondary school students, the teachers need to change their conventional instructional strategies to more active learning strategies (Marfilinda & Indrawati, 2019). To this end, the problemof this study is stated in a question form: what is the effect of the 5Es constructivist learning model on senior secondary school chemistry student's academic achievement in Nomenclature of aliphatic hydrocarbons concept of organic chemistry in Ankpa LGA of Kogi State?

Research Questions

The following research questions were posed to guide the study:

(i). What is the difference in the achievement mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model and those taught using lecture model?

(ii). What is the difference in interest mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model and those taught using lecture model?

(iii). What is the difference in the achievement mean scores of male and female students with 5Es constructivist instructional model?
(iv). what is the difference in the interest mean scores of male and female students with 5Es constructivist instructional model?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 significance level:
HO$_1$: There is no statistically significant difference in the achievement mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist institutional model and those taught using conventional lecture model.
HO$_2$: There is no statistically significant difference in the mean interest score of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model and those taught using conventional lecture model.
HO$_3$: There is no statistically significant difference in the achievement mean scores of male and female students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model.
HO$_4$: There is no statistically significant difference in the interest mean scores of male and female students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model.

Research Method

The study adopted a pretest-posttest non-equivalent quasi-experimental design. The study was carried out in Ankpa which is one of the oldest Local Government in Kogi State. The target population for the study was made up of 2,345 Senior Secondary Schools III chemistry students in all 57 approved secondary schools in Ankpa Local Government Area. The sample of this study comprised of 157 students (70 females and 87 males) SSS III from two intact schools using purposive sampling technique. The schools were randomly assigned to experimental and control groups in a manner that each of the schools has equal and independent chance of been included in the study. The criteria for the selection of schools include: The schools were government co-educational approved schools with functional chemistry laboratory, conducive school environment, WAEC and NECO approved centres for not less than ten years, qualified teachers with first degree in chemistry and with at least 5 years of teaching experience.

Two instruments were developed by the researcher and used for data collection. The instruments were IUPAC nomenclature of aliphatic hydrocarbons Achievement Test (INAHAT) and IUPAC Nomenclature of Aliphatic Hydrocarbons Interest Inventory on IUPAC Nomenclature of Aliphatic Hydrocarbons (INAHII). INAHAT was a 50-item multiple choice questions with option A-D drawn from past West African Examination Council and Unified Tertiary Matriculation Examination questions on IUPAC Nomenclature of Aliphatic Hydrocarbons, designed to assess students' achievement of knowledge gained during the experimentation. INAHII was a 50 items designed to determine students' interest in IUPAC Nomenclature of Aliphatic Hydrocarbons which was rated on using a four-point Likert-type scale of Strongly Agree (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points and Strongly Disagree (SD) = 1 point. The INAHAT and INAHII were subjected to content and face validity by three experts drawn from department of curriculum studies, department of chemistry and measurement

and evaluation, Kogi State College of Education Ankpa. Based on the comments and suggestions from the experts, corrections and modifications were made on the instruments. The instruments were validated by experts and pilot tested. A reliability coefficient of 0.97 was obtained for INAHAT using Kuder-Richardson 21 and 0.92 for INAHII using Cronbach Alpha, implying that the instruments were reliable enough for the study.

Experimental Procedure

A letter of request for permission was taken to the principals of the schools to be involved in the study. After obtaining the permission from the principals, the subject teachers in the selected schools were trained as research assistants on the use 5Es constructivist institutional model using validated lesson packages on IUPAC Nomenclature of Aliphatic Hydrocarbons developed by the researcher. Afterwards, the INAHAT and INAHII were administered to the students as a pre-test to the research groups. After treatment, the reshuffled versions of INAHAT and INAHII were administered by the research assistants as post-test. The experiment lasted for eight weeks. An attempt was made to control and minimize the effects of extraneous variables in the course of data collection. The research questions were analyzed with the use of mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance with the pre-test scores as a covariate.

Presentation of Results

Research Question One: What is the difference in the achievement mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist institutional model and those taught using lecture model?

Table 1: Mean and Standard Deviation of Academic Achievement of Student's taught IUPAC Nomenclature of Aliphatic Hydrocarbons using 5Es Constructivist Institutional Model and Lecture Model.

Treatment Groups	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
5Es Institutional Model	95	13.45	3.64	72.20	15.21	58.75
Lecture Model	62	12.44	3.51	34.24	8.86	21.80

Source: Field Study, 2022. Key: Number of Student and Standard Deviation.

Data in Table 1 show that the achievement gain mean scores of students exposed to 5Es constructivist institutional model is 58.75 is higher than that of lecture model group of 21.80. This is an indication that, students taught IUPAC nomenclature of aliphatic hydrocarbons using 5Es constructivist institutional model achieved better than those who were exposed to lecture model.

Research Hypothesis One: There is no statistically significant difference in the achievement mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist institutional model and those taught using lecture model.

Table 2: ANCOVA Test of Statistical Significant Difference in the Achievement Mean scores of Students taught IUPAC Nomenclature of Aliphatic Hydrocarbons with 5Es Constructivist Institutional Model and Lecture Model.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	η^2
Corrected Model	54069.907[a]	2	27034.954	156.978	.000	.671
Intercept	32696.723	1	32696.723	189.852	.000	.552
Pretest	16.414	1	16.414	.095	.758	.001
Group	53281.675	1	53281.675	309.378	.000	.668
Error	26522.156	154	172.222			
Total	594454.000	157				
Corrected Total	80592.064	156				

a. R Squared = .671 (Adjusted R Squared = .667) p< 0.05.

From the result of ANCOVA in Table 2, it is observed that the significant of F (309.378) with degree of freedom 1:154 for model is 0.000. This value is less than 0.05 probability level set for the study. Hence, the null hypothesis one is rejected. This implies that, there is a statistical significant difference in the achievement mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist institutional model and those taught using lecture model. This favour the 5Es constructivist institutional model group with the mean gain of 58.75 compared to 21.80 mean gain of lecture model group. The partial Eta squared estimated indicates that the treatment accounted for 66.8% of the variance observed in the post-test on the students' academic achievement.

Research Question Two: What is the difference in the interest mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist institutional model and those taught using lecture model?

Table 3: Mean and Standard Deviation of Interest of Students taught IUPAC Nomenclature of Aliphatic Hydrocarbons with 5Es Constructivist Instructional Model and Lecture Model

Treatment Groups	N	Pre-Interest		Post-Interest		Mean Gain
		Mean	SD	Mean	SD	
5Es Institutional Model	95	1.89	0.3354	3.75	0.6237	1.86
Lecture Model	62	1.90	0.3331	2.36	0.2729	0.46

Source: Field Study, 2022.

The results presented in Table 3 show that the interest mean gain score of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model of 1.86 is higher than those taught with lecture model which is 0.46. This implies that students taught IUPAC nomenclature of aliphatic hydrocarbons developed more interest than those taught with lecture model.

Research Hypothesis Two: There is no statistically significant difference in the interest mean scores of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model and those taught using lecture model.

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Table 4: Result of ANCOVA on Students' Interest Mean Scores of Students taught IUPAC Nomenclature of Aliphatic Hydrocarbons with 5Es Constructivist Instructional Model and Lecture Model.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	η^2
Corrected Model	72.189[a]	2	36.095	135.516	.000	.638
Intercept	39.532	1	39.532	148.422	.000	.491
Pre-Interest	.095	1	.095	.355	.552	.002
Group	72.131	1	72.131	270.812	.000	.637
Error	41.018	154	.266			
Total	1722.615	157				
Corrected Total	113.207	156				

a. R Squared = .638 (Adjusted R Squared = .633) p< 0.05.

From the result of ANCOVA in Table 4, it is observed that the significant of F (270.812) with degree of freedom 1:154 for strategy is 0.000. This value is less than 0.05 probability level set for the study. Hence, the null hypothesis one is rejected. This implies that there is statistically significant difference in the interest mean score of students taught IUPAC nomenclature of aliphatic hydrocarbons with 5Es constructivist instructional model and those taught using lecture model. This favour the 5Es constructivist instructional model group with the interest mean gain of 1.86 compared to 0.46 interest mean gain of lecture model group. The partial Eta squared estimated indicates that the treatment accounted for 63.7% of the variance observed in the post-test on the students' interest.

Research Question Three: What are the achievement mean scores of male and female students with 5Es constructivist instructional model?

Table 5: Mean and Standard Deviation of Academic Achievement of Male and Female students taught IUPAC Nomenclature of Aliphatic Hydrocarbons using 5Es Constructivist Instructional model.

Treatment Group	Gender	N	Pre-test		Post-test		Mean Gain
			Mean	SD	Mean	SD	
5Es Instructional model	Male	52	12.9	23.88	75.40	15.23	62.48
	Female	43	13.20	3.23	74.04	14.83	60.84

Source: Field Study, 2022.

Table 5 shows that achievement mean gain of male and female students exposed to constructivist instructional model are 62.48 and 60.84 respectively. This implies that the academic achievement of male and female students exposed to constructivist instructional model is almost at par.

Research Hypothesis Three: There is no statistical significant difference between the academic achievement means scores of male and female students taught IUPAC

Nomenclature of aliphatic hydrocarbons using 5Es constructivist instructional model.

Table 6: ANCOVA test of Statistical Significant Difference in the Mean Achievement Mean Scores of Male and Female Students taught IUPAC Nomenclature of Aliphatic Hydrocarbons using 5Es Constructivist Instructional Model.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	η^2
Corrected Model	333.894[a]	2	166.947	.732	.484	.015
Intercept	39265.752	1	39265.752	172.180	.000	.647
Pretest	61.643	1	61.643	.270	.604	.003
Gender	261.879	1	261.879	1.148	.287	.012
Error	21436.787	94	228.051			
Total	550725.000	97				
Corrected Total	21770.680	96				

a. R Squared = .015 (Adjusted R Squared = -.006) p> 0.05.

From the result of ANCOVA in Table 6, it is observed that the significant of F (1.148) with degree of freedom 1:94 for strategy is 0.287. This value is greater than 0.05 probability level set for the study. Hence, the null hypothesis three is retained. This implies that there is no statistical significant difference in the achievement mean scores of male and female students taught IUPAC nomenclature of aliphatic hydrocarbons using 5Es constructivist instructional model.

Research Question Four: What are the mean interest scores of male and female students with 5Es constructivist learning strategy?

Table 7: Mean and Standard Deviation of Mean Interest Scores of Male and Female students taught IUPAC Nomenclature of Aliphatic Hydrocarbons using 5Es Constructivist Instructional Model.

Treatment Group	Gender	N	Pre-interest		Post-interest		Mean Gain
			Mean	SD	Mean	SD	
5Es Instructional model	Male	52	1.91	0.3382	3.71	0.6421	1.80
	Female	43	1.88	0.3352	3.80	0.6054	1.92

Source: Field Study, 2022.

Table 7 shows that interest mean gain of male and female students exposed to constructivist instructional model are 1.80 and 1.92 respectively. This implies that the interest of male and female students exposed to constructivist instructional model is almost at par.

Research Hypothesis Four: There is no statistical significant difference between the mean interest scores of male and female students taught IUPAC Nomenclature of aliphatic hydrocarbons using 5Es constructivist instructional model.

Table 8: ANCOVA test of Statistical Significant Difference in the Interest Mean Scores of Male and Female Students taught IUPAC Nomenclature of Aliphatic Hydrocarbons using 5Es Constructivist Instructional Model.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	η^2
Corrected Model	.353[a]	2	.176	.448	.640	
Intercept	45.879	1	45.879	116.547	.000	
Pre-interest	.203	1	.203	.517	.474	
Gender	.135	1	.135	.342	.560	
Error	36.216	92	.394			
Total	1371.907	95				
Corrected Total	36.569	94				

a. R Squared = .010 (Adjusted R Squared = -.012) P>0.05

From the result of ANCOVA in Table 8, it is observed that the significant of F (0.342) with degree of freedom 1:92 for strategy is 0.560. This value is greater than 0.05 probability level set for the study. Hence, the null hypothesis four is retained. This implies that there is no statistical significant difference in the mean interest scores of male and female students taught IUPAC nomenclature of aliphatic hydrocarbons using 5Es constructivist instructional model.

Discussion of Results

Results presented in Tables 1 and 2 have shown that students taught IUPAC nomenclature of aliphatic hydrocarbons concept of organic chemistry using 5Es constructivist instructional model and their counterparts taught using lecture model were statistically significant. The findings revealed that 5Es constructivist instructional model was more effective than the lecture model in enhancing students' achievement. This result corroborated several studies (Lasaiba, 2023; Varoglu *et al*., 2023 Muhammad *et al*., 2021; Tolba & Al-Osaimi, 2023; Amaliyah *et al*., 2023; Bunkure, 2019; Garba, 2020; Grau *et al*., 2021) which provided empirical evidences on the effectiveness of 5Es constructivist instructional model in enhancing students' achievement in general. The higher achievement by 5Es constructivist instructional model may be due to the active participation of all the students at every stage of the class. Also, academic achievement of male and female students taught IUPAC nomenclature of aliphatic hydrocarbons using 5Es constructivist instructional model was not statistically significant (see Tables 3 and 4). This implies that 5Es constructivist instructional model is a gender friendly. This is due to the fact that 5Es constructivist instructional model helps students to collaborate and gain from one another in the learning process. This finding agrees with the findings of Garba (2020); Bunkure (2019) and Ematum (2018) who found 5Es constructivist instructional model to be gender friendly.

More so, it was discovered that the use 5Es constructivist instructional model enhanced students' interest in learning IUPAC nomenclature of aliphatic hydrocarbons more than their counterparts taught with lecture model (See Tables 5 and 6). Finally, it was equally revealed that there is no statistically significant difference in the mean interest gain of male and female students exposed to 5Es constructivist learning strategy (see Tables 7and 8). These findings corroborated several studies (e.g.,

Bakri & Adnan, 2021; Iscan & Seyhan, 2021; Itsarangkul Na Ayutthaya & Damrongpanit, 2022) which showed that 5Es instructional model increases students' motivation as well as their interest in studying science and gender friendly.

Implications of the Study

From the conceptual perspective, the outcome of the study indicated effectiveness of 5Es constructivist instructional model students' academic achievement and interest in IUPAC nomenclature of aliphatic hydrocarbons concept organic chemistry. From a pedagogical standpoint, the finding revealed the adoption of 5Es constructivist instructional model helps to enhance interest, classroom interaction, sharing knowledge and academic achievement of students. From the intervention standpoint, it becomes critical for chemistry teachers to use 5Es constructivist instructional model improve both the cognitive and affective domains of students.

Conclusion of the Study

Based on the findings of this study, it is hereby concluded that students exposed to 5Es constructivist instructional model achieved significantly better and improved their interest than students exposed to lecture model. In addition, there was no statistical significant difference between the mean achievement scores and interest of male and female students exposed to 5Es constructivist instructional model. This means that 5Es constructivist instructional model is gender unbiased. This is an indication that using 5Es constructivist instructional model will help students to develop critical thinking, effective problem-solving skills, collaboration skills, communication skills and intrinsic motivation in chemistry concepts.

Recommendations

Based on the findings of this study and their educational implications, the following recommendations are made:

i. The education stakeholders, especially, curriculum planners, State and Federal Ministries of Education should advocate for the inclusion of five stages of 5Es constructivist learning model in the chemistry curriculum for effective teaching and learning in the secondary schools.

ii. The professional bodies like National Teacher's Institute (NTI) and Science Teachers' Association of Nigeria (STAN) should organize seminars/workshops for teachers on how to use five stages of 5Es constructivist learning model for effective teaching and learning of chemistry.

iii. The use of 5Es constructivist learning model seems to be appropriate in improving the achievement of students in senior secondary schools IUPAC nomenclature of aliphatic hydrocarbons concept organic chemistry. It should therefore, be incorporated into the main stream of pedagogy in the teaching of chemistry and other science subjects at senior secondary schools in Kogi state, Nigeria.

iv. Chemistry teachers should expose their students to 5Es constructivist learning model to promote and encourage active learning by experience among learners leading to enhanced academic achievement.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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