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MODELING AS AN INSTRUCTIONAL STRATEGY FOR MOTIVATING, MAINTAINING, AND ENHANCING STUDENTS' INTEREST AND PERFORMANCE IN CHEMISTRY

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Abstract

This study investigated and examined modeling as an instructional strategy for motivating, maintaining and enhancing students' interest and performance in chemistry. Descriptive survey design was used. The sample size used for the study was 120 respondents (students and teachers) randomly selected from two secondary schools and two higher institutions from two Local Government Areas of Edo State, Nigeria. Six research questions, twenty two question items and three null hypotheses were formulated to guide the study. Data were collected from respondents using sets of questionnaire structured in three point rating scale of agreement. The data were analyzed using both descriptive and inferential statistics. The findings shows that the respondents perceived modeling as an effective and impactful instructional strategy which is adequate and to a great extent, could be used to motivate, maintain and enhance students interest and performance in chemistry. The study also shows that modeling is a very adequate instructional strategy in chemistry that is closely related to other complementary alternative instructional strategies on one hand and students' interest and performance in chemistry on the other hand and that modeling could be improved upon for the enhancement and advancement of chemistry by combining it with other complementary strategies. The study recommended that Teachers should be adequately sensitized on the importance of modeling to chemistry among others.

Keywords: Modeling, Instructional Strategy, Student' Interest, Performance, Chemistry.

Introduction

Chemistry is a fundamental science that plays a crucial role in understanding the composition, properties, and transformations of matter. It serves as a cornerstone in various fields such as medicine, engineering, and environmental science, contributing to advancements that shape our modern world. However, despite its significance, many students struggle to engage with and excel in chemistry due to its abstract concepts and complex nature. In response to these challenges, educators continually seek innovative instructional strategies to motivate, maintain, and enhance students' interest and performance in chemistry. One such strategy that has gained attention in recent years is modeling. Modeling involves the use of visual representations, simulations, and hands-on activities to depict chemical concepts and phenomena, making them more tangible and accessible to students.

This study sets out to investigate and examine modeling as an instructional strategy for addressing the motivational and performance issues encountered by students in chemistry. The focus is on understanding how modeling can be leveraged to engage students, sustain their interest, and improve their academic outcomes in this discipline. By exploring the perceptions and experiences of both students and teachers, the study aims to provide valuable insights into the effectiveness and impact of modeling in the chemistry classroom. The rationale for selecting modeling as the instructional strategy of interest stems from its potential to bridge the gap between abstract chemical concepts and students' understanding. Traditional instructional methods often rely on lectures and textbooks, which may fail to capture students' attention or cater to diverse learning styles. In contrast, modeling offers a dynamic and interactive approach that appeals to visual, auditory, and kinesthetic learners, fostering deeper comprehension and engagement.

Furthermore, modeling aligns with constructivist learning theories, which emphasize the active construction of knowledge through hands-on exploration and inquiry. By allowing students to visualize and manipulate chemical structures and processes, modeling encourages active participation and sense-making, empowering students to take ownership of their learning journey. The geographical scope of this study encompasses two secondary schools and two higher institutions located in Edo State, Nigeria. This diverse sampling approach ensures a comprehensive understanding of the perceptions and experiences of both secondary and tertiary level students and educators regarding the use of modeling in chemistry instruction.

Statement of the Problem

A look through science education literatures in the past two decades and summaries of chief examiners' reports of results by external examination bodies for example, the West African Examination Council (WAEC), indicate that all is not well in the teaching and learning process of chemistry. Poor performance of students in chemistry as a subject is on the rise. On an average scale, more than 40% of students who sat for chemistry in the senior secondary school examinations fail. Poor performance as recorded by WACE is also collaborated by results from National Examination Council (NECO), (Omoifo, 2012).

Poor enrolment in chemistry and its related courses is a clear indication that there is a great problem of lack of interest. For the fact that chemistry principles are used in our day to day human activities and its peculiarity in the field of sciences, students ought to be very much interested in chemistry and the level of enrolment ought to be high. But over the years enrolment in the subject has been poor, indicating that the level of interest has significantly dropped.

The national policy statement on chemistry education seek to ensure adequate laboratory and field skills, and relevant knowledge which can be applied to everyday life while maintaining scientific attitude which are reasonable and functional. Given the high value placed on chemistry as one of the core science subject whose knowledge is indispensible in most science and science related courses, and the nature of the subject, the need to teach it effectively through an effective method to enhance students interest and performance is indisputable. A few of the problems affecting the teaching and learning of chemistry are the meaningfulness of the content, the sustainability of the methods and probably, the teacher who handles both the content and method. The incidence of teaching chemistry with ineffective teaching methods and strategies has resulted in lack of motivation and enhancement of students' interest and performance in chemistry. This necessitated the need for a more effective and result-oriented instructional method. What a teacher does in the classroom depends to some degree upon his approach to learning situations. However, students' negative attitudes toward learning may be related to the method of instruction (Dyer, 1995).

For effective teaching and enhanced students' interest and performance in chemistry to take place, the teacher must stimulate, motivate encourage, and maintain active participation of the students, through the selection of appropriate instructional method(s). This would require a balance between what is taught and how it is taught. Thus, successful teaching of chemistry does not depend only on the teachers' mastery of the subject matter but also the teaching method employed. Hence, Ogbonna (2000) opines that one of the most influential factors in teaching is the teacher's method of teaching.

Chemistry is a fundamental discipline that accounts for life at the molecular level. Nevertheless, chemistry instruction at undergraduate level in Nigeria faces the challenge that a majority of the students taking chemistry are neither motivated nor interested in this subject. Most students taking chemistry do not plan to pursue a career in chemistry. They take chemistry simply because it is a prerequisite for their fields of interests; hence, lack of incentives is a profound obstacle to learning. On the other hand, chemistry contains an abundant amount of abstract concepts, which necessitates significant time effort and commitments from the students. The contrast between the low inputs and high demands results in unsatisfactory performance on the students' side and frustration on the instructor's side (Herron, 1996).

Although the motivation enhancement in chemistry career demands national efforts in terms of promoting science and technology, increasing job opportunities, improving salary dynamics *e.t.c.,* a student's interest is another motive that is not justifiable from an economic perspective. For instance, some kids practice for hours in their spare time creating arts, playing instruments, or perfecting their skills in sports simply because they are interested in those practices. Thus, chemistry instructors may also improve students' learning by inspiring students' interest. The question is that "is chemistry really interesting?" Ironically, the answer is only "yes" to a limited number of chemists but not to the general public due to the adoption of tedious teaching methods in chemical education.

Since the level of poor performance in chemistry by students is not unrelated to the consequence of poor teaching methods which in turn results in lack of motivation by the students, the focus of this study therefore, was to understand the nitty-gritty of modeling as an instructional strategy and its ability to expose the fascinating side of chemistry to our students and inspire their curiosity regardless of their career choices.

Objectives of the Study

The aim of the study was to investigate modeling as an instructional strategy for motivating, maintaining and enhancing students' interest and performance in chemistry. To achieve this stated goal, the study will especially examines the use and ability of modeling to ignite, stimulate and sustain students' interest towards the learning of the subject. The specific objectives of the study are:

i. To determine if modeling is an effective instructional strategy in the teaching of chemistry.
ii. To determine the adequacy of modeling as an instructional strategy for the teaching of chemistry.
iii. To evaluate the extent of effectiveness of modeling as an instructional strategy for the teaching and learning of chemistry.
iv. To determine if modeling has the ability to motivate, maintain and enhance students' interest in chemistry.
v. To determine if modeling has the ability to motivate, maintain and enhance students' performance in chemistry.
vi. To examine the extent to which medeling can motivate, maintain and enhance students' interest and performance in chemistry.
vii. To know the possible strategies for improving modeling as an instructional teaching-learning method for the teaching and learning of chemistry

Research Questions

The following research questions guided the study:

1. Is modeling an effective instructional strategy/teaching method?

2. Is modeling as an instructional strategy relevant to chemistry, and to what extent?
3. How relevant is modeling in motivating, maintaining, and enhancing students interest and performance in chemistry?
4. Is modeling as an instructional strategy important and adequate for the advancement of chemistry?
5. What is the relationship between modeling and other instructional strategies used for the teaching of chemistry?
6. What are the possible strategies for improving modeling for the enhancement and advancement of chemistry?

Hypotheses of the Study

The statements of the hypotheses for the study are stated as null. The research has the following statements that will be tested as the formulated research hypotheses:

HO_1: There is no significant difference in the relationship between modeling and students' interest and performance in chemistry.

HO_2: There is no significant difference in the relationship between modeling and the motivation, maintainance, and enhancement of students' interest and performance in chemistry.

HO_3: There is no significant difference between modeling and other complementary instructional strategies for the teaching of chemistry.

Significance of the Study

The study is significant in a number of ways: it will help to increase the teachers' level of awareness and understanding of the use of modeling instructional technique. The findings may also provide chemistry teachers with a feedback on teaching competences and effectiveness of modeling teaching methods as a basis for the motivation, improvement and enhancement of students' performance in chemistry.

To chemistry students, the study will be of immense value since it will bring to their awareness, the ability of models and modeling to either or not help them develop genuine interest in chemistry classes if effective and efficient learning is going to take place, for them to retain what is learnt better and improve on their achievements.

To the curriculum planners, the findings of this study may make it necessary now than before to specify modeling as an appropriate instructional strategy for enhancing students' interest in chemistry and making the subject students centred. This may in turn help teachers/students develop interest in chemistry classes with resultant improved performance.

To the Government and Non-Governmental Organizations, the findings of this study will provide a different point of view if the issue of poor performance of students in chemistry and sciences in general is to be tackled holistically. It will emphasize the need for organizing policies, seminars, lectures, workshops, etc. that will be aimed at developing/improving students interest in chemistry for the advancement of the nation to a higher level in science and technology

To future researchers, the findings of this study will be a source of method, materials and reference for studies on related and similar topics.

Furthermore, this study has both theoretical and practical significance to chemistry in particular and science education, teachers, students', professional bodies and researchers in general. The theoretical bases of this study were Piaget's theory of cognitive development (1954) and Vygotsky's social development theory (1978).

The significance of Jean Piaget's theory of cognitive development is that it recognizes the role of students active involvement in learning activities through a spontaneous interaction with their environment rather than passively waiting for the teacher to present them with ready-made knowledge. According to the social cognitive model of learning, the acquisition of meta-cognitive and self-regulatory skills and competence first develops through social interaction, otherwise known as observational learning. Schunk and Zimmerman suggest that in developing what they call self-regulatory competence, students need to be given opportunities to practice the various strategies associated with self-regulated learning in order to fully develop and master this set of skills. Mastering these skills is made easier when models provide "guidance, feedback, and social reinforcement during practice." (Schunk & Zimmerman, 1996).

Lev Vygotsky's theory of learning emphasizes interpersonal interactions that is, co-operative learning activities in which students engage themselves in learning.

Scope and Limitations of the Study

The scope of study of this research is focused on the use of modeling instructional strategy in enhancing students interest and performance in chemistry.

The study was not without its constraints. Notable among them were the issue of sourcing and gathering of materials, information and data collection and processing such as the questionnaire for the study. The study was also confronted with logistics and geographical factors.

Methodology

Research Design

The descriptive survey statistical research design was eemployed in this study to seek the opinion of the respondents on the research topic. This design involves drawing a sample from the population of interest and measuring the characteristics of the sampled members. Survey as a research methodology is found to be the most suitable option because survey research focuses on people, the vital facts of people and their beliefs, opinions and attitudes. Descriptive Survey as a method will not only be useful in uncovering the importance of "Modeling as an instructional strategy for motivating, maintaining and enhancing student's interest and performance in chemistry" but will also help to relate other possible strategies that can be used to improve modeling for the overall benefit of chemistry.

Population of the Study

The target population was senior secondary school and higher institution chemistry teachers and students. They were selected because they are directly involved in the teaching and learning process. Consequently, they could provide reliable information for the conduct of the study. Two secondary schools and two higher institutions from two local government areas (Etsako West and Esan West) of Edo state, Nigeria, were randomly selected for the conduct of the study.

Sample and sampling technique

The sample size for the study was 120 respondents (students and teachers) randomly selected from two secondary schools and two higher institutions from two local governments area of Edo state. The sample consisted of 60 senior secondary school chemistry students (SSS 111) and teachers from two schools (one public and one private secondary school) in Auchi, Etsako West Local Government Area of Edo State and 60 chemistry students and teachers from two higher institutions (one Polytechnic and one University) in Auchi and Ekpoma, Etsako West and Esan West Local Government Areas of Edo State respectively.

Instrument of Data Collection

The Instrument used to collect data was questionnaire. The questionnaire was the structured form. Questionnaire is a means of eliciting the feelings, beliefs, experiences, perceptions, or attitudes of some sample of individuals (Johnson and Turner, 2003). According to Amedahe (2007), the questionnaire is a very concise, replanted set of questions designed to yield specific information to meet a particular need for research information about a pertinent topic. Questionnaire was used because it can be completed at the respondents' convenience, has wider geographical coverage and offer greater assurance of anonymity and can elicits candid and objective response (s). The questionnaire was divided into two (2) sections. The first section elicits information on respondents' biodata. It consisted of five (5) items and were in closed-ended structured format. The second section was the research questions which seeks informations on the research topic "Modeling as an instructional strategy for motivating, maintaining and enhancing students interest and performance in chemistry" and contains six (6) parts (research questions) with twenty two research items and were of Likert scale type. The responses ranged from "very relevant" to "not rellevant", "yes" to "not sure", "very good" to "bad" and the items were on "assessment of modeling as an instructional strategy" through "relevant of modeling to chemistry" to "possible strategies for improving modeling for the enhancement of chemistry"

Validity of the instrument

The instrument for data collection in the study was well structured and evaluated as valid for eliciting information on "modeling as an instructional strategy for motivating, maintaining and enhancing students' interest and performance in chemistry".

Reliability of the Instrument

The questionnaire instrument used was reliable because all the items in the questionnnaire constantly measured what were relevant to the study and effectively covers all aspects of the research topic.

Method of Data Collection

Copies of the questionnaire were administered personally to the respondents in their schools and offices. Before administering the questionnaires to the participants, the purpose and significance of the study were made known to them. After the administration of copies of questionnaire to the respondents, they were allowed some time to respond to the items in the questionnaire after which the questionnaires were collected on that same day. The rate of return was hundred percent. Relative importance of the study as determined by the respondents and the quality and design of the questionnaire are the factors that affect percentage rate of return of copies of the questionnaire (Key, 1997; Johnson and Turner, 2003).

Method of Data Analysis

Both the descriptive and inferential statistical methods of analysis were used to analysed the data. Percentage method was used to analysed participants' biodata. Mean and Standard deviation methods were also used to analyse data on "modeling as an instructional strategy for motivating, maintaining and enhancing students' interest and performance in chemistry". The single sample t-test and F-test (Anova) statistical tool were used to test the hypotheses at 0.05% level of significance. The Chi square and pearsons' correlation coefficient were also used to analysed the different variables to test the results of the study.

Results

Both the descriptive and inferential statistical methods of analysis were used to analysed the data. Percentage method was used to analysed participants' biodata. The results from the psychographic data were performed and statistically analysed using both descriptive and inferential statistics. The descriptive statistical analysis shows the mean, median, 95% confidence interval, the minimum, maximum, skewness, kurtosis e.t.c. The analysis also shows the normality and variances homogeneity of the results of the study at $p < 0.005$ significance level.

The inferential statistics used to test the hypotheses and analysed the results of the study were the single sample t-test, analysis of variance (Anova), Chi square analysis and the pearson correlation coefficient.

Analysis of Respondents' Biodata

Table 4.1 Gender of Respondents

S/N	Sex	No. of Respondents	Percentage (%)
1	Male	58	48.3
2	Female	62	51.7
	Total	120	100

Table 4.1 shows that 58 respondents which represent 48.3% of the total sample were males while 62 respondents representing 51.7% were females.

Table 4.2 Age Bracket of Respondents

S/N	Age	No. Of Respondents	Percentage%
1	15-25	82	68.3
2	26-35	21	17.5
3	36 and above	17	14.2
	Total	120	100

Table 4.2 shows that 82 respondents which represent 68.3% of the total sample were within the age range of 15 and 25, 21 respondents representing 17.5% of the total sample were within the age bracket of 26 and 35 while 17 respondents representing 14.2% of the total respondents were aged 36 and above.

Table 4.3 Marital Status of Respondents

S/N	Marital Status	No. Of Respondents	Percentage%
1	Married	29	24.2
2	Single	91	75.8
	Total	120	100

Table 4.3 above shows that 29 respondents which constitute 24.2% of the total respondents were married, while 91% respondents representing 75.8% of the total sample were single.

Table 4.4 Respondents by Academic Qualification

S/N	Qualification	No. of Respondents	Percentage%
1	FSLC	42	35.0
2	S.S.C.E	21	17.5
3	NCE/ND	29	24.2
4	BSc/HND	17	14.2
5	MSc/Phd	11	9.1
	Total	120	100

Table 4.4 above indicates that 42 respondents representing 35.0% of the total respondents were first school leaving certificate holders, while 21 respondents representing 17.5%, 29 respondents representing 24.2%, 17 respondents representing 14.2% and 11 respondents representing 9.1% of the total sample were S.S.C.E, NCE/ND, BSc/HND and MSc/PhD holders respectively

Table 4.5 Respondents by Occupation

S/N	Occupation	No. of Respondents	Percentage%
1	Self employed	06	5.0
2	Civil servant	27	22.5
3	Students	83	69.2
4	Others	04	3.3
	Total	120	100

Table 4.5 shows that 06 respondents representing 5.0% of the total respondents were self employed, while 27 respondents which is 22.5% of the total sample were civil servants and 83 respondents which represents 69.2% of the sample were students. 3.3% of the respondents selected others as their occupation.

Presentation and Analysis of Psychographic Data Collected

Generally, the frequencies (number of respondents) for all three variables in each of the question items were converted to percentages and expressed as mean percentages. From the results, the mean percentage for all the twenty two question items were statistically homogeneous. This indicates that the respondents were from a representative uniform single sample and that the question items consist of the same number of variables each. This also indicates the estimate of the population mean which was collaborated by the observed confidence intervals at a confidence level of 5% ($\alpha = 0.05$). Thus, the percentage mean response of the respondents for each of the question items were not statistically different from each other.

The values of the skewness and kurtosis shows that the data were normally distributed. That is, the response for the different variables follows a normal distribution range.

Table 4.6 Assessment of modeling as an instructional strategy

S/N of Statement item	Variables	Frequency (No of respondents) N=3	Percentage (%)	Mean (%)	S.D	S.E.M	95% confidence interval		Skewness	Decision
							LB	UB		
Statement item 1	Yes	78	65.0	33.3	28.926	16.701	-38.52	105.19	0.978	Yes
	No	10	8.3							
	Not sure	32	26.7							
	Total	120	100							
Statement item 2	Yes	77	64.2	33.3	27.658	15.968	-35.37	102.04	1.233	Yes
	No	13	10.8							
	Not sure	30	25.0							
	Total	120	100							

Statement item 3	Very effective	72	60.0	33.3	26.650	15.386	-32.87	99.54	0.006	Very effective
	Fairly effective	40	33.3							
	Not effective	08	6.7							
	Total	120	100							
Statement item 4	Very effective	72	60.0	33.3	27.538	15.899	-35.07	101.74	-0.271	Very relevant
	Fairly effective	42	35.0							
	Not effective	06	5.0							
	Total	120	100							
	Grand mean and S.D	N=12		33.3	24.041					

As shown in table 4.6 above, research question one (1) has a pooled or grand mean and standard deviation of 33.3 and 24.041 respectively from the four question items investigated with the percentage frequencies showing the median, minimum and maximum. For example, the responses to the variables of "Yes", "No", and "Not sure" in statement item item one (1) shows a median i.e. middle value of 32 (26.7%) and maximum and minimum values of 78(65.0%) and 10 (8.3%) respectively from 120 respondents. The decision for each of the question items were "Yes" for question item 1, "Yes" for question item 2, "Very effective" for question item 3 and "Very relevant" for question item 4. This indicates that majority (higher number and in turn higher percentage) of the respondents agreed that modeling is an effective instructional strategy/teaching method, that modeling has been effective and impactful as an instructional strategy for teaching-learning process, that modeling as an instructional teaching-learning method has been very effective and that modeling is very relevant as an instructional strategy. These findings are in concord and agreement with the statement of Kim and Chin (2011) that worldwide, teaching sciences becomes meaningful when the content is delivered through stimulating methods and that inquiry-based learning is a trending method that is widely used to help learners acquire knowledge and skills in a long-lasting manner.

Table 4.7 Relevance of modeling to chemistry

S/N of statement item	Variables	Frequency (No of Respondents) N=3	Percentage	Mean (%)	S.D	SEM	95% confidence interval		skewness	Decision
							LB	UB		
Statement item 5	Very high High Low	52 45 23	43.3 37.5 19.2	33.3	12.579	7.262	2.09	64.58	-1.327	Very high
Statement item 6	Very relevant	72	60.0	33.3	27.538	15.899	-35.07	101.74	-0.271	Very relevant

	Fairly relevant Not relevant	42 06	35.0 5.0							
Statement item 7	Large extent Low extent Not relevant	83 30 07	69.2 25.0 5.8	33.3	32.511	18.77	-47.43	114.1	1.078	Large extent
Statement item 8	Very relevant Fairly relevant Not relevant	88 26 06	73.0 21.7 5.0	33.3	35.437	20.459	-54.8	121.26	1.309	Very relevant
	Grand mean and S.D	N=12		33.3	28.413					

Table 4.7 shows that four items were investigated for research question 2 with a pooled or grand mean and standard deviation of 33.3 and 28.413 respectively. The frequencies and percentage frequencies indicates the variable that represents the median, maximum and minimum in each of the question item. The decision for each of the question item were "Very good" for question item five (5), "Very relevant" for question 6, "Large extent" for question item 7 and "Very relevant" for question item 8. This implies that majority of the respondents agreed and accepted that chemistry teachers/students have very high relevance for modeling as an instructional strategy, that modeling as an instructional strategy is very relevant to chemistry and to a large extent, and that modeling is very relevant in motivating, maintaining and enhancing students interest and performance in chemistry. This is in line with the submissions of Araromi (1998) and Abimbade (1997) who in a review of empirical studies on instructional models, concluded that improvised instructional models enhance visual imagery, stimulates learning and assists the teacher to properly convey the topic content to the learner, to achieve better understanding and to perform well.

Table 4.8 Assessment of modeling as a tool for the advancement of chemistry

S/N of statement item	Variables	Frequency (No of Respondents) N=3	Percentage	Mean (%)	S.D	SEM	95% confidence interval		Skewness	Decision
							LB	UB		
Statement item 9	Yes No Not sure	87 04 29	72.5 3.3 24.2	33.3	35.493	20.492	-54.84	121.5	1.081	Yes
Statement item 10	Yes No Not sure	87 04 29	72.5 3.3 24.2	33.3	35.493	20.492	-54.84	121.5	1.081	Yes
Statement item 11	Yes No	91 06	75.8 5.0	33.3	37.456	21.625	-59.71	126.38	1.456	Yes

	Not sure	23	19.2							
Statement item 12	Very effective Fairly effective Not effective	80 34 06	66.7 28.3 5.0	33.3	31.156	17.988	-44.06	110.73	0.708	Very effective
Statement item 13	Large extent Low extent Not sure	95 04 21	79.2 3.3 17.5	33.3	40.351	23.297	-66.9	133.57	1.494	Large extent
Statement item 14	Very pleased Pleased Not pleased	47 48 25	39.2 40.0 20.8	33.3	10.862	6.271	6.35	60.31	-1.721	Pleased
	Grand mean &S.D	N=18		33.3	33.265					

Table 4.8 above shows that research question three (3) has a grand mean and standard deviation of 33.3 and 33.265 respectively. The decision for the question items were "Yes" for question items 9, 10, and 11, "Very effective" for question item 12, "Large extent" for question item 13 and "pleased" for question item 14. Thus, agreeing to question question items 9, 10 and 11 in the affirmative and that modeling has been very effective and impactful in the the teaching-learning of chemistry, that modeling can motivate, maintain and enhance students interest and performance in chemistry to a large extent, and that majority of the respondents were pleased with the extend to which modeling has affected students interest and performance in chemistry. This statement is in agreement with the assertion of Okoh, (2005). that Good teaching method(s) bring about the desired students learning; the majority of students in a classroom will respond positively and demonstrate academic growth when instruction is appropriately designed to meet their learning needs.

Table 4.9 Adequacy of modeling as an instructional in chemistry

S/N of statement item	Variables	Frequency (No of Respondents) N=3	Percentage	Mean (%)	S.D	SEM	95% confidence interval		Skewness	Decision
							LB	UB		
Statement item 15	Very adequate Adequate Not adequate	63 49 08	52.5 40.8 6.7	33.3	23.795	13.738	-25.78	92.44	-1.273	Very adequate
Statement item 16	Very good Good/effective Bad	96 23 01	80.0 19.2 0.8	33.3	41.448	23.93	-69.63	136.3	1.356	Very good
	Total	N=06		33.3	33.795					

As shown in table 4.9 above, research question four (4) has a grand mean and standard deviation of 33.3 and 33.795 respectively. The median in the two question items (questions 15 and 16) are 49 and 23 respectively. The maximum frequencies and percentage frequencies are 63 (52.5%) and 96 (80.0) percent respectively. 08 (6.7%) and 01 (0.8%) represents the minimum in the two question items respectively. The decisions were "very adequate" and "very good/effective" respectively, affirming that modeling is very adequate for motivating, maintaining and enhancing students interest and performance in chemistry and that it will be good and effective to combine modeling with other instructional strategies/teaching methods. These findings corroborates and are in concord with the opinions of other researchers that successful teaching of chemistry does not depend only on the teachers' mastery of the subject matter but also the teaching method employed. Hence, Ogbonna (2000) opines that one of the most influential factors in teaching is the teacher's method of teaching. Also, According to Keene (2008), each student learns best using strategies and objectives that reflect his/her experiences, abilities, aptitudes and interest. Similarly, there is no standard teaching method. The various teaching methods overlap in definition and application; none being mutually exclusive although researchers often delineate several teaching strategies. Modeling technique is one of the many teaching learning style under the investigative or activity based. It is a method which is capable of improving learning through its diversity and effective activity. It has the prerequisite characteristics for individualized instruction and therefore has high potential for making teaching-learning process challenging and rewarding.

Table 4.10 Relationship of modeling with other instructional strategies

S/N of statement item	Variables	Frequency (No of Respondents) N=3	Percentage	Mean (%)	S.D	SEM	95% confidence interval		Skewness	Decision
							LB	UB		
Statement item 17	Yes No Not sure	26 51 43	21.7 42.5 35.8	33.3	10.617	6.13	6.96	59.71	-0.989	No
Statement item 18	Yes No Not sure	61 15 43	50.8 12.5 36.7	33.3	19.371	11.184	-14.79	81.45	-0.758	Yes
Statement item 19	Close related Fairly related Not related	81 28 11	67.5 23.3 9.2	33.3	30.417	17.562	-42.23	108.89	1.323	Closely related
Statement item 20	Large extent Low extent Not sure	66 26 28	55.0 21.7 23.3	33.3	18.781	10.843	-13.32	79.99	1.719	Large extent
	Total mean and S.D	N=12		133.2	79.186					

From table 4.10 above, the respondents views on the relationship of modeling with other instructional strategies are showed. The grand mean and standard deviation are 33.3 and 21.011 respectively. Statement item 17 has a "No" decision, statement item 18 has a "Yes" decision while statement items 19 and 20 have "closely related" and "Large extent" decisions, all being the views with the highest frequencies and percentage frequencies. This confirmed that majority of the respondents agreed that there is no significant difference between modeling and other alternative instructional strategies/methods such as the experiment method, that there would be difference in the interest and performance of students taught chemistry by modeling and students taught chemistry using other instructional strategies, that modeling and other complementary alternative instructional strategy on one hand, and students interest and performance in chemistry on the other hand are closely related, and that modeling would depend on other instructional strategies/methods to a large extent. This corroborate the assertion of Adunola (2011) that teachers need to be conversant with numerous teaching strategies that take recognition of the magnitude of complexity of the concepts to be covered.

Table 4.11 Possible strategies used for improving modeling for the enhancement of chemistry

S/N of statement item	Variables	Frequency (No of Respondents) N=3	Percentage	Mean (%)	S.D	SEM	95% confidence interval		Skewness	Decision
							LB	UB		
Statement item 21	Yes No Not sure	93 03 24	77.5 2.5 20.0	33.3	39.238	22.654	-64.14	130.8	1.353	Yes
Statement item 22	Most likely Like Unlikely	88 24 08	73.3 20.0 6.7	33.3	35.245	20.349	-54.22	120.89	1.459	Most likely
	Total mean and S.D	N=06		33.3	37.295					

Table 4.11 above captures the respondents' views on possible strategies for improving modeling for the enhancement of chemistry. The grand or pooled mean and standard deviation are 33.3 and 37.295 respectively. Their views indicates that modeling as an instructional strategy can be improved upon to motivate, maintain and enhance students interest and performance in chemistry. They also agreed that most likely possible strategies for improving medeling to motivate, maintain and enhance students interest and performance in chemistry may likely include; availability of adequate instructional materials, motivation, re-inforcement of students, teachers attitude and experience, conducive learning environment, use of complementary instructional strategies/methods such as role playing, experiment method, analogy, demonstration, observation, field trip and discussion methods e.t.c. This is in line with the submission of

Duschl, (1990), that the availability of teaching and learning materials, competency of teachers and the environment in which a school is located have an impact on students' academic performance.

Table 4.12 shows the normality test for the twenty two (22) question items using the Shapiro-wilk test. The Shapiro-wilk test for normality at P< 0.05 significance level show that all the question items passed the test as their p-values were all greater than 0.05 except that of question item three (3) whose level of significance was less than 0.05. This implies that the distribution of the different data follows a normal distribution range, hence, parametric methods of analysis were used to analysed the data rather than non-parametric methods. This is even more true, as the data collected from the respondents were converted to percentages and expressed as percentage means.

Table 4.12 Normality test (p<0.05)

S?N of Statement item	Shapiro-wilk test		
	w	p.value	Passed test
1	0.9606	0.6182	True
2	0.9319	0.4959	True
3	1.0	<0.0001	False
4	0.9973	0.9000	True
5	0.9177	0.4443	True
6	0.9973	0.9000	True
7	0.9507	0.5725	True
8	0.9206	0.4543	True
9	0.9503	0.5708	True
10	0.9503	0.5708	True
11	0.8932	0.3643	True
12	0.9804	0.7320	True
13	0.8845	0.3378	True
14	0.7812	0.0704	True
15	0.9262	0.4744	True
16	0.9128	0.4275	True
17	0.9595	0.6131	True
18	0.9774	0.7115	True
19	0.9184	0.4467	True
20	0.786	0.0814	True
21	0.9134	0.4295	True
22	0.8927	0.3625	True

Table 4.13 Variances homogeneity test (p<0.05)

Test	Test statistics	P value	Passed test
F-test	N/A	N/A	N/A
Absolute levene test	0.9024	0.5892	True
Brown-forsythe test	0.2294	0.9997	True
Bartlet's test	8.6745	0.9916	True
Squared levene test	0.9145	0.5755	True

The variances homogeneity test was carried out using the F-test, absolute Levene test, Brown-Forsythe test, Bartlet's test and the squared Levene test. As shown in table 4.13, there was no answer (N/A) for the F-test while all other tests shows the data passed variances homogeneity test at 5% significance level since all P-values are greater than 0.05. This implies that there exist homogeneity in the differences between the standard deviations and the means of the various data in the different question items.

Table 4.14 Single sample t-test analysis to test the research questions

Test	Research question	Grand mean	Grand S.D	N	Calculated t-value (t-calculated)	Critical t-value (t-critical)	Level of significance p(two tailed)<0.005	Statistical significance	Decision
Single Sample t-test	RQ1	33.3	24.041	4	0.025	3.1824	0.9817	False	Accepted
	RQ2	33.3	28.413	4	0.0268	3.1824	0.9803	False	Accepted
	RQ3	33.3	33.265	6	0.0221	2.5706	0.9832	False	Accepted
	RQ4	33.3	33.795	2	0.0126	12.7062	0.992	False	Accepted
	RQ5	33.3	21.011	4	0.0286	3.1824	0.979	False	Accepted
	RQ6	33.3	37.295	2	0.0114	12.7062	0.9928	False	Accepted

The equal variance or pooled single sample t-test was used to determine the significance of difference of the means from the different question items using the pooled or grand means and standard deviations from each from each research question and thus, used to test the hypotheses of the study at 0.05 level of significance i.e P (two-tailed)< 0.05. The calculated t-values (t-calculated) for all the six research questions at 0.05 level of significance as shown in table 4.14 were less than their corresponding critical t-values (t-critical). This results also shows that the p values were all greater or higher than 0.05 which means that the null hypotheses were all accepted and that there was no statistical significance differences in the percentage means responses and by extension, the grand percentage means responses for all the research questions.

Table 4.15 Single sample t-test to test the research hypothesis using the total grand mean and S.D

Test	Total grand mean	Total grand S.D	N	Calculated t-value	Critical t-value	Level of significance p(two sided)<0.005	Statistical significance	Decision
Single sample t-test	33.3	29.637	6	0.2727	2.5706	0.796	False	Accepted

Table 4.15 show the t-test result for the total grand mean and standard deviation. The total pooled single sample t-test was used to test the research topic i.e the positive impact or otherwise of modeling on students interest and performance in chemistry by testing the hypotheses using the total pooled means and standard deviations from all the six research question with twenty two (22) question items at 0.05 level of significance. The t-calculated was lesser than the t-critical and the level of significance (p) was greater than 0.05. This means that there was no significance difference in the percentage means responses of the respondents and hence, all the hypotheses were accepted. This results implies that all the six research questions were answered in the affirmative and that modeling as an instructional tool can be used to motivate, maintain and enhance students' interest and performance in chemistry. This agrees with the statement that Learning is viewed as a function of observation, rather than direct experience and that students' personality traits, personal goals and motivation as well as the support from teachers and the teacher's level of experience significantly influence the academic performance of students (Ulate & Carballo, 2011).

Table 4.16 Analysis Of Variance to Test The Hypothesis Using The Pooled Or Grand Means

Test	Research questions	df	Calculated f-value	Critical f-value	Significance level p(two tailed)<0.005	Statistical significance	Decision
One way Anova test (f-statistics)	RQ1	11	0.0	4.0662	1.0	False	Accepted
	RQ2	11	0.0	4.0662	1.0	False	Accepted
	RQ3	15	0.0	3.1059	1.0	False	Accepted
	RQ4	5	0.0	-	1.0	False	Accepted
	RQ5	11	0.0	4.0662	1.0	False	Accepted
	RQ6	5	0.0	-	1.0	False	Accepted

Table 4.17 Analysis of variance (Anova) to test the research hypothesis using the total grand mean

Test	Calculated f-value	Critical f-value	Significance level p(two tailed)<0.005	Statistical significance	Decision
One-way Anova test	0.0	1.8009	1.0	False	Accepted

Table 4.16 and 4.17 above shows the one-anova test to determine if there was any significance difference in the means of the data. This results shows that the calculated F—values for all the the research questions were the same (0.0) and lower than their corresponding critical F-values. The significance level (p) for all the question items were also the same (1.0) and greater or higher than 0.05. These implies that the means were

homogeneous (the same) and that there was no significance differences in the means hence, all three hypotheses were accepted.

Table 4.18 Chi square (X^2) Analysis to test the Research topic

Test	Calculated chi-square value	Critical chi-suare value	Significance level p(two tailed)<0.005	Statistical significance	Decision
Chi-square test	406.5587	58.124	P<0.001	True	Categorical variables diifers significantly

Table 4.18 shows the Chi-square analysis for the distribution of the categorical variables at $p < 0.05$. The calculated chi-square value (406.5587) was greater than the tabulated chi-square value (58.124) at 5% level of significance and the value for p was less than 0.05. This implies that there was statistical significance difference in the distribution of the categorical variables hence, the various categories of variables in the twenty two question items have somewhat statistical significance differences.
Pearson correlation coefficient was also used to evaluate the relations between the variables. The results shows that there was total positive linear correlation for all the group of questions except for question item 17 that gave a total negative linear correlation to other groups. Generally, the P values of the correlations at $P < 0.05$ for most of the variables shows that there was no statistical significance differences in the correlation of the different results with those with significance difference clearly astericked.

Conclusion

The study investigated the role of modeling as an instructional strategy in motivating, maintaining and enhancing students' interest and performance in chemistry. In light of the fact that learning is a process that involves investigating, formulating, reasoning and using appropriate strategies to solve problems, teachers should realise that it becomes more effective if teaching and learning process is students base rather than teachers centred. A typical learning of chemistry with just a presentation from the course teacher accompanied by a lecture neither promotes learners' participation, interest, motivation nor build the required level of reasoning among students. Students build a better understanding of the main concepts more effectively when they are engaged to solve problems during class activities using effective instructional strategies such as modeling. In general, inadequate conceptual understanding of chemistry is the common problem students taking chemistry face. This problem is worsened with the lack of motivation

and interest. However, an experience teacher can help students overcome these problems by making chemistry vivid, simple and understandable to attract, motivate, enhance students interest and performance with the help of modeling as an instructional strategy.
Furthermore, modeling is not an instructional strategy that can be easily wished away as it continues to increase its status as an indispensible tool in the teaching-learning process of chemistry.
From the findings of this study, it is here by concluded that modeling is an effective instructional strategy/teaching method that is very effective, impactful, relevant to a very large extent with the ability to motivate, maintain and enhance students interest and performance in chemistry. It is also a very adequate instructional strategy in chemistry that is closely related to other complementary alternative instructional strategies on one hand and students interest and performance in chemistry on the other hand. However, modeling could be improved upon for the enhancement and advancement of chemistry by combining it with other complementary strategies such as role playing, analogy, demonstration (by audio visuals), field trips, e.t.c.
Conclusively, the study upholds and accepted the statement of the hypotheses in null hence, there is no significant difference in the relationship between modeling and students interest and performance in chemistry, there is also no significant difference in the relationship between modeling, motivation, maintainance, and enhancement of students interest and performance in chemistry. And lastly, there is also no significant difference between modeling and other complementary instructional strategies for the teaching and learning of chemistry.

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