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EFFECT OF 7E LEARNING CYCLE MODEL ON STUDENTS' ATTITUDE TOWARDS CHEMISTRY AT SECONDARY SCHOOL LEVEL

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ABSTRACT

The study investigated the c in Taraba State, Nigeria. Quasi-experimental design was adopted for the study. The population comprised all secondary school two (11th grade) students offering chemistry in 2023/2024 academic session. 200 students were purposively sampled for the study. Chemistry Achievement Test (CAT) was used as data collection tool with a reliability coefficient of 0.83 which was considered good and suitable for the study. The data collected were analyzed using descriptive (mean, standard deviation & graph), and inferential statistics. The results showed that: i) There is a significant difference between the mean attitude scores of students taught chemistry using 7E model and students taught using guided discovery; ii) There is no significant difference between mean attitude scores of male and female students taught chemistry with 7E's model; and iii) There is no significant difference between the interaction effects of method, gender on students' mean attitude scores in chemistry. The study concluded that the 7E model which is gender-friendly, had great enchantment and capable to boost positive attitudes in students towards chemistry. Hence, 7E learning cycle model is recommended for class lessons in order to promote active learning and all-inclusiveness for attitudinal change.

Keywords: 7E learning cycle model, Attitude, Chemical (redox) reactions, Gender

Introduction

Conceptual understanding is highly required for the learners to get proper learning outcomes and positive attitudes toward scientific concepts. Many researchers have conducted many ways to improve students' conceptual understanding; and one of which according to Balta and Sarac (2016) is through learning models; and one of the learning models that has been proven in improving students' conceptual understanding is the constructivism (Jack & Ogunleye, 2024). There are various types of constructivism learning models, such as problem-solving, mind mapping, and 7E learning cycle. In this research, the 7E Learning Cycle model is selected to ascertain if since it will provide chances for learners to build their knowledge and stimulate positive attitudes in students (Febriana at al., 2014; Jack & Ogunleye, 2024).

The 7E instructional approach is a comprehensive instructional model that accommodates various methods, such as cooperative learning, group work, lectures, laboratory investigations and direct instruction which enables students to explore their beliefs and allow them to construct new knowledge. The 7E learning cycle model is a

student-centered, inquiry learning strategy that lays the foundation for proper conceptualization by students through various activities, spread across seven (7E) phases which includes Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend (Eisenkraft, 2003). These 7E learning phases allow students to correct their misconceptions through exploration, and facilitate clarification by the teacher, and aided by explanations by the students themselves (Jack & Ogunleye, 2024). The 7E model of instructional delivery similarly deepen understanding of concepts by other activities, such as evaluating students' conception against acceptable scientific explanations, as well as the extension (application) of obtained knowledge to new situations (Gok et al, 2014); or learning difficult chemistry concepts.

The 7Es are explained below are coined from Balta and Sarac (2016) from the simplest to the complex:

(a) Eliciting: This phase of the instructional model activates student's prior knowledge. The teacher tries to raise or brings in student initial knowledge (prioritizes prior knowledge or understanding which will later become the foundation of the new knowledge) by giving fundamental questions relating to the material to be studied.

(b) Engaging (involving): this activity aims to get students attention, encourage their thinking skills and help them access the initial knowledge they already have. That is linking the past and the present information.

(c) Exploration (investigating): Students are given opportunity to work both independently and in groups without direct instruction or direction from the teacher. Students manipulate an object, conduct experiments, investigate, observe, and collect data, to make preliminary conclusions from experiments conducted.

(d) Explanation (explaining): Teacher encourages students to explain the concept and definitions they understand in their own words and show examples related to the concept to complete the explanation. Their conceptual understanding, or demonstrate their skills or behaviors. This phase also provides opportunities for teachers to introduce a formal label or definition for a concept, process, skills or behavior.

(e) Elaboration (outlining): Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Where students apply symbols, definition, concepts and skills to problems related to the example to the examples of lessons learnt.

(f) Evaluation (assessing): where the teacher evaluates the learning outcomes which has been done. At this stage a variety of assessment strategies can be used both formally and informally

(g) Extending: where students are required to think, search, discover, and explain examples of the application of new concepts and skills that have been learned.

The seven stages in the 7E learning cycle model by Eisenkraft (2003) are the steps taken by teachers and students in applying this learning strategy in class, Students and teachers have their activity undertaken. This

is so that the advantages and benefits of this model can be felt.

Some of the likely benefits of the constructivist instructional strategy as viewed by these educationists (Candra & Achmadi, 2017; Marfilinda, 2019; Jack & Ogunleye, 2024) are it can help; i) stimulate student to recall previous material; ii) improve student learning towards better achievement because this instructional strategy prioritizes students experience, it also can also form active, critical and creative students; iii) motivate students to be more active and increase curiosity; and iv) train students to learn concepts through experimental activities etc.

The constructivist model could help in improving students' attitude towards science. Attitude is one of the vital determinants of an individual's actions. Although, there are many definitions of attitude, all the views agree that an attitude is an individual's disposition to think, feel, or act positively or negatively toward objects in his or her environment. Marcela and Mala (2016), in a study discovered that learner's attitudes toward school were a determinant factor that predicts their academic achievement. The implication of the study, therefore, is that a positive attitude gives rise to positive results while a negative attitude turns out a negative result. Attitude refers to the predisposition to categorize objects and events, to react to them with assessment consistency. Attitude consists of one's information, reverence, emotions, incitement, and self-esteem designing an individual's outlook on a certain discipline. Students exhibit a certain attitude towards chemistry by reacting according to their understanding rather than to its actual state. In a study conducted by Hacieoglu (2015) on students' attitude toward science, the findings showed that students who had a more positive attitude towards science had higher achievement scores. Also, attitude can be said to be the emotional and mental entities that propel an individual to take any action towards an object or subject.

Another factor to be considered in the study is gender. Gender is the fact of being male or female. Umoru (2016) defines gender as a socio-cultural and psychological dimension of being a male or female. It is a moderator variable of this study. The influence of gender being the dependent variables was explored due to empirical gaps in literatures which embracing optimum learning opportunities can help close the gender attitude gaps. This simply implies that learning opportunity requires a shift from conventional strategy of teaching to a suitable pedagogical strategy.

This study is concerned with the alarming crisis in relation to the issue of ineffective teaching/learning strategies on students' attitude and gender; which has been a burning issue mostly in difficult concepts in chemistry such as chemical reactions or oxidation-reduction reactions (redox reaction). Since constructivist strategy is acknowledged as one of the best innovative method for teaching, there is a need to try such innovative teaching strategy to determine if there is gender influence on

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student's attitude of redox reaction in chemistry. Hence, the problem of this study is to find out the effect of 7E's learning cycle model on students' attitude towards chemistry in secondary schools in Taraba State. The study also investigated the influence of gender and on students' attitude in chemistry when exposed to 7E's learning cycle model and guided discovery. It is against this background that this research was carried out in order to establish the effect of 7E's learning cycle model on students' attitude in Chemistry.

The purpose of this study is to investigate the effect of 7E's learning cycle model on students' attitude of redox reaction in Chemistry in Jalingo Education Zone, Taraba State, Nigeria. Specifically, the study sought to:

i. Determine the mean attitude scores of students taught using 7E's learning cycle model and students taught using guided discovery.

ii. Find out the mean attitude scores of male and female students taught chemistry with 7E's learning cycle model and students taught using guided discovery.

iii. Determine the interaction effects of method, gender on students' mean attitude scores in chemistry.

Research Questions

Based on the objectives stated, the following research questions were raised to facilitate the investigation,

i. What are the mean attitude scores of students taught using 7E's learning cycle model and students taught using guided discovery?

ii. What are the mean attitude scores of male and female students taught chemistry with 7E's learning cycle model and students taught using guided discovery?

iii. What are the interaction effects of method, genders on students' mean attitude scores in chemistry?

Hypotheses

From the research questions raised, the following null hypotheses were postulated and tested at 0.05 level of significance:

$H0_1$: There is no significant difference between the mean attitude scores of students taught chemistry using 7E's learning cycle model and students taught using guided discovery.

$H0_2$: There is no significant difference between mean attitude scores of male and female students taught chemistry with 7E's learning cycle model and students' taught chemistry using guided discovery.

$H0_3$: There is no significant difference between the interaction effects of method, gender on students' means attitude scores in chemistry

Methodology

The quasi-experimental design was used for the study. The population of the study consisted of all the students offering chemistry from the public secondary schools in 2023/2024 academic session in Jalingo Education Zone, Taraba State, Nigeria. Quasi-experimental design was adopted for the study. The study population comprised all secondary school two (11^{th} grade) students offering Chemistry. A sample size of 200 (146 males & 54 females) students were

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drawn from two (2) intact classes in two public secondary schools through purposive sampling. The students were assigned to two groups, namely: the experimental group (7E instruction model) and the control group (Guided-discovery) respectively.

The instrument used for data collection is a modified four (4) point rating scale Students Attitudes towards Chemistry (SATC) scale which is a standardized Chemistry Attitudes Survey adapted from Salta and Tzougraki (2004) which is made up of 40 items. The SATC reliability index was determined with Cronbach Alpha (α) and the reliability coefficient was 0.83; which indicate the suitability and reliability of the instrument. The SATC was employed before (pre-test) and after the treatment (post-test) in order to determine the students' attitudes in chemistry. These procedures of data collection was applicable to both groups (experimental and control). The data collected was analyzed using mean and standard deviation to answer the questions; while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at $p<0.05$ level of significance.

Results

Research Question One: What are the mean attitude scores of students taught using 7E's learning cycle model and students taught using guided discovery? Table 1 was used to answer research question one.

Table 1: Mean Attitude and Standard Deviation of Pre-attitude and Post-attitude of Experimental and Control Groups

Group		Pre-attitude		Post-attitude		Mean
	n	Mean	Std.Dev.	Mean	Std.Dev.	Difference
7E model	140	34.56	4.08	94.81	6.54	60.25
Guided discovery	60	34.58	3.40	77.93	7.06	43.35
Mean Difference		0.02		16.88		16.90

Results in Table 1 show that the post-attitude mean scores of students taught Chemistry using 7E's learning cycle model is 94.81 with standard deviation of 6.54, while that of those taught using Guided discovery (GD) is 77.93 with standard deviation of 7.06. The difference between the Pre-attitude and Post-attitude mean scores of 7E model is 60.25 and that of Guided discovery is 43.35. The implication is that the students taught Chemistry using 7E model acquired positive attitude more than their counterparts taught using higher than their counterparts taught using GD. There is also a difference of 16.88 between the post-attitude mean scores of the two groups; which favour the 7E's learning cycle model group; but to ascertain if the difference was significant was tested with $H0_1$.

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Hypothesis One: There is no significant difference between the mean attitude scores of students taught chemistry using 7E's learning cycle model and students taught using guided discovery learning strategy.
The test of $H0_1$ at 0.05 level of significance is presented on Table 2.

Table 2: One-way Analysis of Covariance of Mean Attitude Scores of the Experimental and Control Groups

Source of Variation	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	11960.798[a]	2	5980.399	132.685	.000	.574
Intercept	18031.423	1	18031.423	400.058	.000	.670
Pre-Attitude	2.329	1	2.329	.052	.820	.000
Group	**11959.160**	**1**	**11959.160**	**265.334**	**.000**	**.574**
Error	8879.197	197	45.072			
Total	1631673.000	200				
Corrected Total	20839.995	199				

Table 2 is one-way ANCOVA between groups analysis of covariance to compare the effect of 7E's learning cycle model and Guided discovery learning on students' attitude in chemistry. The result F (1, 197) = 265.334, P = .000 < 0.05 shows that the two groups differ significantly. Thus, the null hypothesis is not retained. Therefore, there is a significant difference between the mean attitude scores of students taught chemistry with 7E's learning cycle model and students taught with Guided discovery learning. The effect size (eta square = .574) is very high and it indicates that 57.4% of the difference in the mean score is based on the strategy used.

Research Question Two: What are the mean attitude scores of male and female students taught chemistry with 7E's learning cycle model and students taught using guided discovery learning strategy?
Table 3 was used to answer research question two.

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Table 3: Mean Attitude Score and Standard Deviation of Pre-attitude and Post-attitude based on Gender of Experimental and Control Group

Group		Pre-attitude		Post-attitude		Mean	
	n	Mean	Std.Dev.	Mean	Std.Dev.	Gain	
EXP male	97	34.85	4.07	95.02	6.44	60.17	
EXP female	43	33.93	4.08	94.33	6.81	60.40	
Mean Difference		0.92		0.69		0.23	
Ctrl male	49	34.84	3.37	77.61	6.89	42.78	
Ctrl female	11	33.45	3.47	79.36	7.98	45.91	
Mean Difference		1.38		1.75			3.13

Results of Table 3 show that the post-attitude mean scores of male students taught chemistry with 7E's learning cycle model is 95.02 with standard deviation of 6.44, while that of the female students is 94.33 with standard deviation of 6.81. The difference between the pretest and posttest mean scores of the male students is 60.17 and that of the female students is 60.40. The difference between the posttest mean scores of the two gender is 0.69 and the mean gain is 0.23; in favour of the female students. The implication is that the female students taught chemistry using 7E's learning cycle model had positive attitude more than their male counterparts

Also on the same table, it can be observed that the post-attitude mean scores of male students taught chemistry with Guided Discovery Learning Strategy is 77.61 with standard deviation of 6.89, while that of the female students is 79.36 with standard deviation of 7.98. The difference between the pre-attitude and post-attitude mean scores of the male students is 42.78 and that of the female students is 45.91. The difference between the posttest mean scores of the two gender is 1.75 and the mean gain is 3.13; in favour of the female students. The implication is that the female students taught chemistry using Guided discovery had positive attitude more than their male counterparts; but to ascertain if the difference was significant was tested with $H0_2$.

Hypothesis Two: There is no significant difference between mean attitude scores of male and female students taught chemistry with 7E's learning cycle model and guided discovery.
The test of $H0_2$ at 0.05 level of significance is presented on Table 4.

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Table 4: Two-way Analysis of Covariance of Mean attitude scores of male and female of the Experimental and Control Groups

Source of Variation	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	12002.939[a]	4	3000.735	66.215	.000	.576
Intercept	18031.821	1	18031.821	397.893	.000	.671
Pre-Attitude	2.523	1	2.523	.056	.814	.000
Group	7222.060	1	7222.060	159.363	.000	.450
Gender	8.606	1	8.606	.190	.663	.000
Group* Gender	41.750	1	41.750	.921	.338	.005
Error	8837.056	195	45.318			
Total	1631673.000	200				
Corrected Total	20839.995	199				

Table 4 is two-way ANCOVA between groups' analysis of covariance to assess the effect of 7E's learning cycle model and Guided discovery learning on male and female students in chemistry. After adjusting the mean for the pre-test scores, the result F (1, 195) = .921, P = .338 > 0.05 shows that the mean attitude scores of male and female students' taught Chemistry using 7E's learning cycle model and Guided discovery learning of male and female students do not differ significantly. Hence, the null hypothesis two is not rejected. Also, the effect size (eta square = .005) is low; hence the effect size is insignificant. The effect size indicates that only 5% of the difference in the mean score is based on the strategy used.

Research Question Three: What are the interaction effects of method, genders on students' mean attitude scores in chemistry
Figure 1 was used to answer research question three.

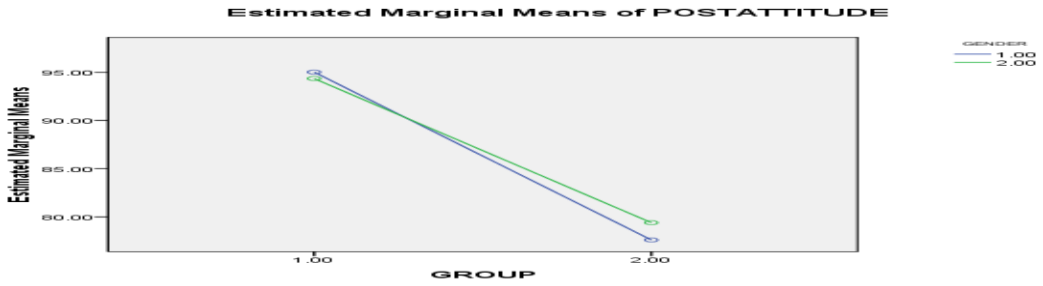


Fig 1: Interaction effect of method and gender on students' mean attitude score in Chemistry

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In Figure 1, the profile plot/graph shows the interaction effect of method and gender on students' attitude in Chemistry. The interaction pattern shows that the plots for males and females intercept between 7E's learning cycle model (experimental group) and Guided discovery learning strategy (control group). This indicates that there is interaction effect between method and gender. The interaction is tenable in this case when 7E's learning cycle model is used with Guided discovery learning in chemistry class; ; but to ascertain if the difference was significant was tested with $H0_3$.

Testing Hypothesis three

There is no significant difference between the interaction effects of method, gender on students' mean attitude scores in chemistry.

The test of $H0_3$ at 0.05 level of significance is presented on Table 5.

Table 5: Two-way Analysis of Covariance of Interaction Effect of Method, Gender on Students' Mean Attitude Score in Chemistry

Source of Variation	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	12002.939[a]	4	3000.735	66.215	.000	.576
Intercept	18031.821	1	18031.821	397.893	.000	.671
Pre-Attitude	2.523	1	2.523	.056	.814	.000
Method	7222.060	1	7222.060	159.363	.000	.450
Gender	8.606	1	8.606	.190	.663	.000
Method* Gender	41.750	1	41.750	.921	.338	.005
Error	8837.056	195	45.318			
Total	1631673.000	200				
Corrected Total	20839.995	199				

Table 5 is two-way ANCOVA between groups' analysis of covariance to assess the effect of 7E's learning cycle model and Guided discovery learning (GDS) on male and female students in chemistry. After adjusting the mean for the pre-test scores, the result F (1, 195) = .921, P = .338 > 0.05 shows that the mean attitude scores of male and female students' taught Chemistry using 7E's learning cycle model and Guided discovery learning (GDS) of male and female students do not differ significantly. Hence, the null hypothesis two is not rejected. Also, the effect size (eta square = .005) is low; hence the effect size is insignificant. The effect size indicates that only 5% of the difference in the mean score is based on the strategy used.

Discussion of Findings

Analysis of covariance was conducted to determine the effects of 7E's learning cycle model on students' attitude of Chemistry.

The independent were methods (7E's learning cycle model and Guided Discovery Learning Strategy), where gender is considered as a moderator variable. The dependent variable is attitude. The findings of this study are summarized thus:

i. There is a significant difference between the mean attitude scores of students taught chemistry using 7E's learning cycle model and students taught using guided discovery learning strategy.
ii. There is no significant difference between mean attitude scores of male and female students taught chemistry with 7E's learning cycle model and guided discovery
iii. There is no significant difference between the interaction effects of method, gender on students' mean attitude scores in chemistry.

The first finding showed that there is a significant difference between the mean attitude scores of students taught chemistry using 7E's learning cycle model and guided discovery learning strategy. This implies that 7E's learning cycle model adopted in teaching of chemistry is significant in enhancing students' attitude in chemistry. This therefore implies that the two strategies are not of equal strength. This study agrees with what was earlier found by Marcela and Mala (2016), in a study discovered that learner's attitudes toward school were a determinant factor that predicts their academic achievement. That there is significant difference between students who were taught using 7E's learning cycle model and those taught using Guided discovery learning.

On the findings based on the effect of gender on students' attitude in Chemistry; it showed that there is no significant difference in the attitude between male and female students that were taught using the 7E's model. The finding of the study agrees with what was earlier found by Kosobameji (2022) that there is no significant difference in the attitude between male and female students in the 7Es Constructivist Instructional model although in Kosobameji (2022) in both cases, the male students had better attitude than their female counterpart.

On the interaction effect of method and gender on students' attitude in chemistry, the finding showed that 7E's learning cycle model had significant effects on the students' attitude. This is attested to previous works which revealed that the 7E instructional model helped in the improvement of students' achievement/and retention (Jack & Ogunleye, 2024; Nilda, 2021; Sumiyati et al., 2016; Villacrusis & Beloy, 2021), and enhance learning outcomes and promote critical thinking skills **(**Marfilinda, et al., 2019; Maskur et al., 2019; Yuberti et al. 2019); hence improved attitude of the students irrespective of their gender. This implies that, there is no significant difference between the interaction effects of method and gender on students' mean attitude scores in chemistry.

Conclusion and Recommendation

From the results of the findings, it is evident that the use of 7E's learning cycle model could provide a good way for students to learn concepts of Redox reaction and chemistry in general. It is therefore concluded that the use of 7E's learning cycle model could be incorporated with the conventional guided discovery method used at the secondary school level to help improve students' attitude towards learning chemistry.

The practical implication of the findings of the study is that it has added to the existing body of knowledge and provided additional empirical evidences that 7E's learning cycle model is an effective strategy with more meaningful and result-oriented learning in imparting skills and acquiring a better understanding of redox reaction concepts; hence improvement on students' attitudes towards difficult chemistry concepts.

Based on the conclusion drawn, the study recommends as it borders on chemistry education that; chemistry teachers should adopt constructivist /inquiry learning models like 7E's learning cycle model as this strategy will enhance the attitudes of many more students to the subject positively and is gender friendly. 7E learning cycle model is also recommended for class lessons in order to promote active learning and all-inclusiveness for attitudinal change.

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