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EFFECTIVENESS OF 7E CONSTRUCTIVIST INSTRUCTIONAL STRATEGY ON STUDENTS' KNOWLEDGE RETENTION OF DIFFICULT CONCEPTS IN CHEMISTRY

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ABSTRACT

Worried by difficulties encountered by students' in retaining some difficult chemistry concepts such as chemical (redox) reactions, the study aimed towards boosting secondary school students' retention using 7E constructivist instructional model in Taraba State. 200 students offering chemistry in 2023/2024 session were purposively sampled for the study. Chemistry Achievement Test (CAT) was used as data collection tool with a reliability coefficient of 0.77 which was considered good and suitable for the study. The results showed that there was a statistically significant difference between the mean retention scores of students taught Chemistry using 7ECIS and those taught using the conventional guided discovery method. However, insignificant difference based on gender. The study concluded that the 7E model which is gender-friendly had great enchantments and capable to boost students' retention of difficult chemistry concepts; hence recommended for class lessons.

Keywords: 7E instructional model, Knowledge retention, Redox reaction, Gender

Introduction

One of the learning models that has been proven in improving students' conceptual understanding is the constructivism such as 7E learning cycle model. The 7E Learning Cycle model is a constructivist instructional strategy that provides chances for learners to build their knowledge and help them to elaborate their understanding of certain aspects of scientific research (Jack & Ogunleye, 2024). The learning cycle model was developed from 3E (Exploration, Explanation,
Elaboration), 5E (Engagement, Exploration, Explanation, Elaboration, and Evaluation), and 7E (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend).

Some studies suggest that the 7Es learning cycle can foster motivation and learning achievement (Febriana et al., 2014; Jack & Ogunleye, 2024; Sumiyati et al., 2016), improve language comprehension (Balta & Sarac, 2016), sufficient to achieve learning goals quickly (Bozorgpouri, 2016), improve the ability of mathematical connections (Rawa et al., 2016), foster conceptual understanding (Nurmalasari et al., 2014; Rahman & Chavhan, 2022), and boost knowledge retention (Abdullahi et al., 2021a&b; Adolphus et al., 2021; Villacrusis & Beloy, 2021). More so, the cycles of the applied 7E learning model are emphasized in the understanding of the scientific chemistry concepts, misconception correction and knowledge transfer/retention of concepts considered as difficult by the students. And,

one of the chemistry topic that is considered quite difficult for students to understand is redox reaction.

Oxidation-reduction (redox) reaction is a type of chemical reaction that involves a transfer of electrons between two species in which the oxidation number of a molecule, atom, or ion changes by gaining or losing an electron; oxidation refers to the loss of electrons while reduction refers to the gain of electrons by a substance (Jack, 2023; Jack & Ogunleye, 2024). Concepts in electrochemistry (such as oxidation-reduction reactions) are considered to be challenging to secondary (high) school students with associate alternative conceptions and difficulties in understanding and retention.

Retention is the act of transferring information from short term memory to long term memory; and it comes in before recall which reveals how much knowledge the students have retained after the teaching and learning (Jack & Ogunleye, 2024). Retention is a term used to describe the ability to recall learning outcome after a period of time. Gatlin (2018) reported that for knowledge to be retained for a long time by the learners, the teachers must use effective instructional techniques in the classroom since it encourages students' active participation for a long lasting memory.

The issue of knowledge retention based on gender in science has been a burning issue coupled by worry by difficulties encountered by students' in retaining some difficult chemistry concepts such as chemical (redox) reactions, hence the study aimed towards boosting secondary school students' knowledge retention in these concepts using 7E instructional model.

The main purpose of this study was to investigate the effectiveness of 7E constructivist instructional strategy on students' knowledge retention of redox reaction in Chemistry in Jalingo Education Zone, Taraba State, Nigeria. Specifically, the study

i. Determine the mean retention scores of students taught using 7E Constructivist Instructional strategy (7ECIS) and students' taught using guided discovery learning strategy.

ii. Find out the mean Retention scores of male and female students taught chemistry with 7E Constructivist Instructional strategy (7ECIS) and students' taught using guided discovery learning strategy.

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

Research Questions

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

i. What are the mean retention scores of students taught using 7E Constructivist Instructional learning strategy (7ECIS) and students taught using guided discovery learning strategy?

ii. What is the mean retention scores of male and female students taught chemistry with 7E Constructivist Instructional strategy (7ECIS) and students' taught using guided discovery learning strategy?

iii. What are the interaction effects of method, genders on students' mean retention 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 retention scores of students taught using 7E Constructivist Instructional strategy (7ECIS) and students' taught Chemistry using guided discovery learning strategy.

$H0_2$: There is no significant difference between the mean retention scores of male and female students taught chemistry with 7E Constructivist Instructional strategy (7ECIS) and students' taught chemistry using guided discovery learning strategy.

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

Research Method

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. The sample of the study was 200 (146 males and 54 females) SSII students offering chemistry drawn from two (2) intact classes in two public secondary schools through purposive sampling.

The testing instrument used for data collection was a 28-items Chemistry Retention Test (CRT on oxidation and reduction reaction (Redox reaction) topics.

In the administration of the instrument, the CAT instrument was administered in two phases. The first phase was the administration of pre-test (Pre-CAT) to the student of experimental and control groups; which took place a week before treatment. After pre-test administration, the students were taught (treatment stage) the topics in the unit redox reaction for four (4) weeks in the same intact classes using 7ECIS (experimental group) and guided discovery learning strategy (control group) by the trained research assistants (teachers). The second phase was the administration of a Post-test (Post- CAT) to the same set of students of both groups; which was after the treatment, to determine students' achievement.

On the method of data analysis, the data collected was subjected to analysis at two different levels; descriptive and inferential statistics. At the descriptive levels, mean and standard deviation were used to answer the questions. While at the inferential level; the Analysis of Covariance (ANCOVA) was used to test the hypotheses (H0I-H03) at $p<0.05$ level of significance.

Presentation of Results

Research Question One: What are the mean retention scores of students taught using 7E Constructivist Instructional learning strategy (7ECIS) and students taught using guided discovery strategy?

Table 1: Mean Achievement and Standard Deviations of Pretest and Post-posttest of Experimental and Control Groups

Group	Pretest			Post-posttest		Mean
	n	Mean	Std.Dev.	Mean	Std.Dev.	Gain
7ECIS	140	14.99	3.47	35.86	5.91	20.87
GDS	60	15.80	4.01	31.75	6.75	15.95
Mean Difference		0.81		4.11		4.92

Results in Table 1 shows that the post-posttest mean achievement scores of students taught Chemistry using 7Es Constructivist Instructional Strategy is 35.86 with standard deviation of 5.91, while that of those taught using Guided Discovery Learning Strategy is 31.75 with standard deviation of 6.75. The mean gain between the Pre-test and Retention mean scores of 7Es Constructivist Instructional Strategy is 20.87 and that of Guided Discovery Strategy is 15.95; these differences show the retention by the two groups. There is also a difference of 4.11 between the post-posttest mean scores of the two groups and the mean gained by the experimental group is 4.92.The implication is that the students taught Chemistry using 7E Constructivist Instructional Strategy gained in retention more than those taught Chemistry using Guided Discovery Learning Strategy.

Research Question Two: What are the mean retention scores of male and female students taught chemistry with 7E Constructivist Instructional strategy (7ECIS) and students taught using guided discovery learning strategy?

Table 2: Mean Achievement and Standard Deviations of Pretest and Post-posttest based on Gender of Experimental and Control Groups

Group	Pretest			Post-posttest		Mean
	n	Mean	Std.Dev.	Mean	Std.Dev.	Gain
EXPmale	97	14.80	3.50	35.53	6.38	20.72
EXPfeamale	43	15.40	3.42	36.60	4.67	21.21
Mean Difference		0. 60		1.07		0.49
Ctrlmale	49	15.88	4.01	31.29	6.86	15.41
Ctrlfemale	11	15.45	4.20	33.82	6.10	18.37
		0.43		2.53		2.96

Results of Table 2 show that the post-posttest mean achievement scores of male students taught chemistry 7Es Constructivist Instructional Strategy is 35.53 with standard

deviation of 6.38, while that of the female students is 36.60 with standard deviation of 4.67. The difference between the pretest and post- posttest mean scores of the male students is 20.72 and that of the female students is 21.21. The difference between the post- posttest mean scores of the two gender is 1.07 and the mean gain is 0.49; in favour of the female students. The implication is that the female students taught chemistry with 7Es Constructivist Instructional Strategy gained in retention more than their male counterparts.

Also on the same table, it can be observed that the retention mean scores of male students' taught chemistry with Guided Discovery Learning Strategy is 31.29 with standard deviation of 6.86, while that of the female students is 33.82 with standard deviation of 6.10. The difference between the pretest and post-posttest mean scores of the male students is 15.41 and that of the female students is 18.37. The difference between the posttest mean scores of the two gender is 2.53 and the mean gain is 2.96; in favour of the female students. The implication is that the female students taught chemistry with Guided Discovery Strategy retained more than their male counterparts.

Research Question Three: What are the interaction effects of method, genders on students' mean retention scores in chemistry?

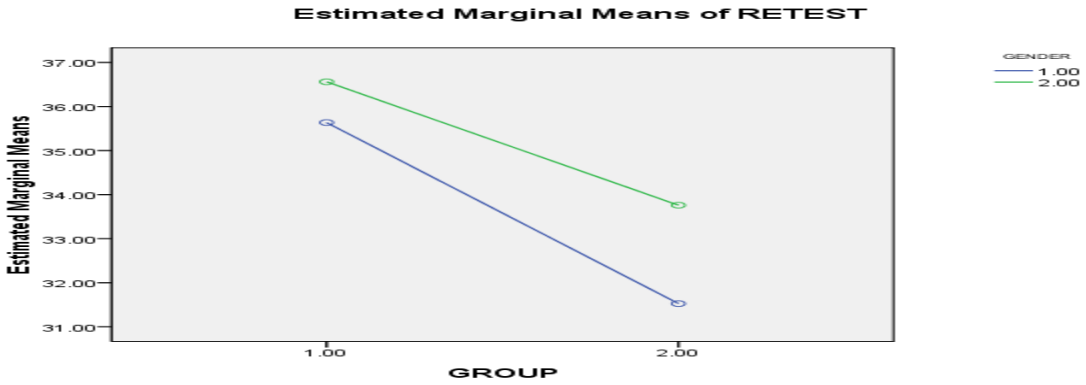


Fig 1: Interaction effect of method and gender on students' mean retention score in chemistry

In Figure 1, the profile plot/graph shows the interaction effect of method and gender on students' retention in Chemistry. The interaction pattern shows that the plots for males and females do not intercept, and the lines are apart, though not parallel to each other. This indicates that there is likelihood of an interaction between method and gender in retention of chemistry for 7Es Constructivist Instructional Strategy and Guided Discovery Learning Strategy. But when the plot is extrapolated the intersection could only be at infinity, which means that the interaction effect between method and gender may be tenable in this case.

Hypothesis Three ($H0_3$): There is no significant difference between the interaction effects of method, gender on students' mean retention scores in chemistry.

Table 3: Two-way Analysis of Covariance of Interaction Effect of Method, Gender on Students' Mean Retention Scores in Chemistry

Source of Variation	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	1005.419[a]	4	251.355	6.761	.000	.122
Intercept	9038.953	1	9038.953	243.135	.000	.555
Pretest	204. 645	1	204.645	5.505	.032	.027
Method	370.952	1	370.952	9.978	.004	.049
Gender	87.679	1	87.679	2.358	.178	.012
Method * Gender	20.778	1	20.778	.559	.577	.003
Error	7249.456	195	37.177			
Total	248033.000	200				
Corrected Total	8254.875	199				

Table 3 is two-way ANCOVA between groups' analysis of covariance to assess the effect of 7Es Constructivist Instructional Strategy (7ECIS) and Guided Discovery Learning Strategy (GDLS) on male and female students in chemistry. After adjusting the mean for the pre-test scores, the result F (1,195) = .559, P = .577 > 0.05 shows that the mean retention scores of male and female students' taught Chemistry using 7Es Constructivist Instructional Strategy (7ECIS) and Guided Discovery Learning Strategy (GDLS) of male and female students do not differ significantly. Hence, the null hypothesis two is not rejected. Also, the effect size (eta square = **.**003) is low; hence the effect size is insignificant. The effect size indicates 3% difference in the mean score is based on the strategy used**.**

Discussion of Findings

Analysis of covariance was conducted to determine the effects of 7Es Constructivist Instructional Strategy (7ECIS) on students' knowledge retention in chemistry. The independent were methods (7Es Constructivist Instructional Strategy and Guided Discovery Learning Strategy), where gender is considered as a moderator variable. The dependent variable is knowledge retention. The findings of the study is summarized as follows:

i. Students taught Chemistry using 7Es Constructivist Instructional Strategy gained in retention than their counterparts taught Chemistry using Guided Discovery Strategy counterparts; the difference is significant.

ii. Female students taught Chemistry with 7Es Constructivist Instructional Strategy and Guided Discovery Strategy gained in retention more than their male counterparts; though statistically insignificant.

iii. There is no interaction effect of method and gender on students' knowledge retention in Chemistry.

The findings of this study are discussed under the following sub-headings: i) Effect of 7Es Constructivist Instructional Strategy on students' knowledge retention in chemistry; ii) Effect of gender on students' knowledge retention in chemistry; and iii) Interaction effect of method and gender on students' knowledge retention in chemistry.

The result based on the effect of 7Es constructivist instructional strategy on students' retention showed that; students taught Chemistry using 7Es Constructivist instructional strategy gained in retention than their counterparts taught Chemistry using Guided discovery strategy counterparts; the difference is significant. As observed in the result of the study, it can be concluded that the students taught Redox using 7Es Constructivist Instructional strategy gained in retention more than their Guided Discovery Strategy counterparts. This is supported by the null hypothesis two that there is no significant difference between the mean retention scores of the students taught Chemistry using 7Es Constructivist Instructional strategy and that of the students taught Chemistry using Guided Discovery Strategy was rejected. The finding agrees with these previous researchers (Abdullahi et al., 2021 a & b; Adolphus et al., 2021; Villacrusis & Beloy, 2021) which revealed that there was statistically significant difference between the retention mean academic achievement of students taught different science concepts using 7Es learning cycle and those taught using the conventional lecture method. The outcome of the result favoured students in the experimental group. The quality of the data indicated that the learning approach enhance student's curiosity and retention ability of students.

The result based on the effect of gender of students' retention in Chemistry showed that the differences between male and female students in four groups are not statistically significant which implies that the variation of scores for male and female students is about the same. The finding based on retention agrees with that of Abdullahi et al. (2021) in Bauchi State result revealed that 7Es learning strategy has positive effect on the retention ability of the students; and the learning approach enhance student's curiosity and retention ability of students. The finding also agrees with that of Villacrusis and Beloy (2021), whose results showed that there was a significant difference between the retention test and posttest mean scores of the experimental and control groups; and the retention of previously gained concept in science was significant in the lag test scores of the experimental group. The finding also agrees with that of Villacrusis and Beloy (2021), whose results showed that there was a significant difference between the posttest and pretest mean scores of the experimental and control groups while retention of previously gained concept in science was significant in the lag test scores of the experimental group. The finding also agrees with that of Libata et al. (2021) on the effectiveness of 7E Inquiry Integrated Module which revealed that the experimental group students evidenced more knowledge retention of concepts than the control group students. This shows that the 7ECIS is an

effective way of improving students' retention of concepts.

The finding based on students' knowledge retention agrees with Maskur et al. (2019) who revealed that the use of the 7E Learning Cycle model is sufficient to improve the learners' understanding of temperature and heat concepts. And, this was seen from the success of the learning process that integrated the whole seven stages with the seven indicators of conceptual understanding. Thus, the 7E Learning Cycle could be effectively applied and can increase the students' conceptual understanding. The finding also agrees with the results analysis by Khashan (2016) in Saudi Arabia showed that the 7E Learning Cycle has a positive longitudinal effect on retention than the traditional method.

The implication of this finding suggests that the adoption of the 7ECIS improves students' retention in Chemistry. Thus, teachers may use the 7ECIS in making daily lesson plan in teaching science subjects (and chemistry in this case) to enhance retention of previously gained concepts of students The findings also imply that students are able to remember what they were taught, after a time lapse, which enhances their chance of passing chemistry tests or examinations.

On the interaction effect of method and gender on students' knowledge retention in chemistry; the findings showed that 7es Constructivist Instructional Strategy had significant effects on the students' knowledge retention in chemistry. However, the students' gender did not have significant effect on their retention of concepts taught. The implication is that there is no significant effect of gender and method on students' retention in Chemistry. The findings of this study agrees with Adewale and Effiong (2015) study from southern part of Nigeria, which revealed that interaction effects of teaching strategy and gender have no significant effect on students' retention. However, the findings disagreed with finding of Amaefuna, (2020) study from south-east Nigeria, which revealed that there is a significant difference in the mean retention scores between male and female students; and also contradicts. Summarily, the findings revealed that in as much as method have significant effect on knowledge retention of students, the interaction effects of method and gender have no significant effect on students 'retention in redox reaction concepts in chemistry.

Conclusion

From the results of the findings, it is evident that the use of 7Es Constructivist Instructional Strategy 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 7Es Constructivist Instructional Strategy would enhance students' retention of chemical concepts more than the guided discovery strategy. The study concluded that using 7Es Constructivist instructional strategy has the potentials of improving the recalling ability of students in chemistry lessons. Furthermore, the strategy is gender friendly and as well increases students' knowledge retention in Chemistry. Thus, the strategy can be used to address the present trend of poor knowledge retention among secondary school students in 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 7Es Constructivist Instructional Strategy is an effective strategy with more meaningful and result-oriented learning in imparting skills and increasing retention of the acquired knowledge on chemical concepts. The strategy also helped students in developing creative, critical and analytical thinking skills which them to construct knowledge on their own than the guided discovery method.

Recommendations

The implication of this study and the associated recommendations as it borders on chemistry education are as follows:

1. Chemistry teachers should adopt constructivist /inquiry methods like7Es constructivist Instructional Strategy as this strategy will help students' have higher knowledge retention in redox reaction concepts in chemistry. This strategy should be encouraged and integrated in chemistry lessons as it is gender-friendly, and exposes students to dynamics and richness of the subject.
2. With the introduction of 7Es constructivist Instructional Strategy there was more effectiveness in teaching of chemistry and enhancing student's retention in chemical concepts, hence the Ministries of Education should ensure that textbook authors incorporate this innovative, effective and efficient strategy in secondary schools.
3. Chemistry teacher trainees should be trained on how best to involve students during instructions of 7Es constructivist Instructional Strategy so as to facilitate students' knowledge retention in chemical concepts in class lessons. This could be achieved through seminars and workshops for teachers in secondary schools.

REFERENCES

Abdullahi, A. C., Jubrin, A. G., Dauda, M. O. & Danjuma, I. M. (2021a). Effect of 7Es learning strategy on retention on secondary school students in biology in Bauchi Metropolis, Bauchi State, *Nigeria Global Journal of Education, Humanities and Management Sciences (GOJEHMS)*, 3(1), 125 – 136.

Abdullahi, S., Asniza, I. N., & Muzirah, M. (2021b) Effect of 7E Instructional Strategy on the achievement and remembering of students in bıology in public secondary schools in Adamawa State, Nigeria. *Journal of Turkish Science Education*, 18(4), 748-764. *DOI* no: 10.36681/tused.2021.101

Adewale, G. J. & Effiong, E. O. (2015). Effect of two methods on students' achievement in junior secondary schools in Yakurr, Cross River State. *International Letters of Social and Humanistic Sciences*, 61, 70-81.

Adolphus, T., Omeodu, M. D., Naade, N.; Ubaka, D. O., & Echenu, F. (2021). Effect of 7E Instructional Approach on Senior Secondary School Student's Achievement and Interest in Chemical Equilibrium in Delta State. *International Journal of Advance Research and Innovative Ideals in Education*, 8(4), 684-694.

Amaefuna, A. I. (2020) Effect of 5 Step constructivist-based instructional model on students' retention in *Biology. International Journal of Science and Research (IJSR) SJIF:* 7.803.

Balta, N., & Sarac, H. (2016). The effect of 7E learning cycle on learning in science teaching: A meta-Analysis study *European journal of Educational Research* 5(2), 61-72.

Bozorgpouri, M. (2016). The study of effectiveness of Seven-Step (7E) teaching method in the progress of English learning in students Shir4az City. *The Turkish Online Journal of Design, Art and Communication*, 6(2016), 341–346.

Eisenkraft, A. (2003). Expanding the 5E model: A proposed 7E model emphasizes "transfer of learning" and the importance of eliciting prior understanding. Retrieved from: http://emp.byui.edu/firestonel/bio405/readings/learning%20models/expanding%205e.pdf

Febriana, E., Wartono, W. & Asim, A. (2014). The effectiveness of the learning cycle 7e learning model accompanied by recitation on the learning motivation and achievement of Class XI MAN 3 Malang students. *Online Journal of Malang State University*, 2(1), 1–13.

Gatlin, L. S. (2018). *The effect of pedagogy informed by Constructivism: A comparison of students' academic achievement across Constructivism and traditional classroom environment.* Unpublished Doctoral Dissertation, University of New Orlan.

Jack, G. U. (2023). Towards improving secondary school students' retention in difficult chemistry concepts using computer simulations, problem solving and concept mapping in collaborative learning environments. *International Journal of Innovative Social & Science Education Research,* 11(3), 20-35.

Jack, G. U. & Ogunleye, D. O. (2024). Improving secondary school students' academic achievement in Chemistry using 7Es constructivist instructional strategy. *International Journal of Innovative Social & Science Education Research,* 12(1):61-83.

Khashan, K. (2016). The effectiveness of using the 7E learning cycle strategy on the immediate and delayed mathematics achievement and the longitudinal impact of learning among preparatory year students at King Saud University (KSU) *Journal of Education and Practice*, 7(36), 40-52.

Libata, I. A., Ali, B. M. N. & Ismail, H. N. (2021). Constructivist approach to learning activity: The case of junior secondary students' misconception on the three states of matter in Basic Science, Nigeria. *Equity Journal of Science and Technology,* 8(1), 8 – 18.

Maskur, R.; Latifah, S.; Pricilia, A.; Walid, A., & Ravanis, K. (2019). The 7E learning cycle approach to understand thermal phenomena. *Jurnal Pendidikan IPA Indonesia,* 8(4), 464-474. *http://journal.unnes.ac.id/index.php/jpii JPII.*

Nurmalasari, R., Kade, A., & Kamaluddin (2014). The effect of the type 7E learning cycle model on the understanding of physics concepts in grade vii students of SMP Negeri 19, Palu. Tadulako, *Physics Education Journal* (JPFT), 1(2), 2–7.

Rahman, S., & Chavhan, R. (2022). 7E Model: an effective instructional approach for teaching learning. *EPRA International Journal of Multidisciplinary Research,* 8 (1), 339-345.

Rawa, N. R., Sutawidjaja, A., & Sudirman, S. (2016). Development of learning cycle-7e model-based learning devices on trigonometry material to improve students' mathematical connection ability. *Journal of Education: Theory, Research, and Development,* 1(6), 1042-1055.

Sumiyati, Y., Sujana, A., & Djuanda, D. (2016). Application of the 7E learning cycle model to improve student learning outcomes in the material of the water cycle process. *Scientific Pen Journal,* 1(1), 41-50.

Villacrusis, E. M. & Beloy, R. T. (2021). Improving students' achievement and retention of learning in environmental science using 7es instructional model *International Journal on Advance Research (IJAR).* *http://dx.doi.org*/10.21474/IJAR01/12546