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INFLUENCE OF ADVANCE ORGANIZERS ON STUDENTS' ACADEMIC PERFORMANCE AND RETENTION IN REDOX-REACTION CONCEPT AMONG SENIOR SECONDARY SCHOOLS IN MAIDUGURI, BORNO STATE

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ABSTRACT

This study examined the influence of advance organizers on students' academic performance and retention in redox-reaction concept in Chemistry among senior secondary schools in Maiduguri Metropolis, Borno State, Nigeria. A quasi-experimental, non-equivalent control group pre-test–post-test and postpost-test design was employed. A sample of 365 students (148 males and 217 females) drawn from four intact classes across two schools participated in the study. The experimental group was taught redox-reaction concepts using advance organizer instructional strategy, while the control group received instruction through the conventional lecture method. Data were collected using a researcher-developed Redox Reaction performance Test (RRPT), validated by expilotperts and -tested for reliability. Bar chart was used to answer the research question, while independent sample t-tests were used to test the hypotheses at a 0.05 level of significance. Findings revealed that students taught using advance organizers performed significantly better (Mean = 61.01) than those taught using conventional methods (Mean = 31.79), with a statistically significant difference ($t = 23.878$, $p < 0.05$). Moreover, no significant gender differences were found in either academic performance or retention, indicating that the advance organizer strategy is equally effective for male and female students. The study concludes that advance organizers instructional strategy enhances learning, improve academic performance and support content retention in redox-reaction concepts without gender bias. It is recommended that chemistry teachers adopt advance organizers as a learner-centered instructional strategy to improve students' understanding of abstract scientific concepts.

Keywords: Advance Organizers, Students' Academic Performance, Retention & Redox-Reaction Concept

Introduction

Education is widely recognized as a key driver of social and economic development, and in Maiduguri Metropolis, the educational sector continues to receive significant attention from government authorities. In Borno State, policy measures such as increased budgetary allocations, provision of instructional materials, deployment of qualified teachers, and long-term subsidization of Senior School Certificate Examination (SSCE) fees reflect sustained efforts to expand access and improve educational outcomes (Borno State Ministry

of Education, 2021). Despite these measures, the academic performance of students in secondary schools, particularly in science subjects like Chemistry, remains a significant concern.

Reports from examination bodies such as the West African Examinations Council (WAEC) and the National Examinations Council (NECO) in recent years have shown that student achievement in Chemistry continues to fall below expectations (WAEC Chief Examiner Report, 2020; NECO Chief Examiner Report, 2021). Poor performance in Chemistry has been linked to instructional factors, including teacher-centered pedagogy, lack of conceptual emphasis, and inadequate use of instructional strategies that promote active learning (OECD, 2022; Akinsola & Afolabi, 2020). As Narad and Abdullahi (2016) observed, despite increased investment in education, academic performance across levels appears to be deteriorating, raising concerns for educators, parents, and policymakers.

Chemistry is a subject inherently rich in abstract concepts that require deep conceptual understanding rather than rote memorization. Topics such as Oxidation-Reduction Reaction (redox reaction) present particular challenges for secondary school students because they involve multiple cognitive constructs including electron transfer, oxidation numbers, balancing complex equations, and application of conceptual rules (Taber, 2019; Johnstone & Reid, 2021). Chief Examiners' reports from WAEC and NECO have repeatedly noted that redox reaction questions are among the least attempted and most poorly answered in external examinations (WAEC, 2018; NECO, 2020), indicating a significant learning gap.

In response to persistent underperformance in Chemistry, educational stakeholders including the Federal Ministry of Education, State Ministries of Education, and tertiary institutions have implemented teacher professional development programmes aimed at enhancing instructional quality (FME, 2021). While such initiatives are valuable, research suggests that the mere presence of trained teachers is insufficient if appropriate instructional strategies are not systematically applied in classrooms (Hattie, 2022; Darling-Hammond et al., 2020).

Instructional strategies that promote cognitive engagement, meaningful learning, and the linking of new information to prior knowledge have been shown to improve students' academic performance and retention (Ausubel, 1968; Novak, 2020). One such strategy is the Advance Organizer, which involves providing learners with an overarching conceptual framework prior to lesson delivery. Advance organizers help students to assimilate new knowledge by activating existing cognitive structures, thereby facilitating comprehension and retention (Merriënboer & Kirschner, 2018; Shams & Ismail, 2020).

Recent studies support the effectiveness of advance organizers in science education. For example, Kwapong et al. (2022) found that advance organizers significantly enhanced students' achievement and conceptual

understanding in Chemistry. Similarly, Adeyemi and Babajide (2021) reported that structured pre-instructional strategies improved learners' performance and sustained interest in abstract science topics compared to traditional lecture methods.

In addition to pedagogical effectiveness, research has highlighted the importance of gender equity in science learning. Gender differences in Chemistry performance have been documented, with female students often underperforming due to sociocultural factors, classroom practices, and instructional biases (UNESCO, 2021; Stoet & Geary, 2020). Identifying instructional strategies that support both male and female learners is critical for narrowing these gaps.

Despite evidence supporting learner-centered approaches, traditional teacher-centered methods characterized by rote memorization and didactic instruction remain predominant in many secondary schools. These methods limit students' cognitive engagement, reduce meaningful learning, and may contribute to poor retention of concepts (Prince, 2020; Smith & Ragan, 2021).

Considering these challenges, there is a pressing need to explore innovative instructional strategies that enhance meaningful learning and improve academic performance and retention. Therefore, this study investigates the role of Advance Organizers in improving students' academic performance and retention in redox reaction in Chemistry. By providing an instructional framework that anchors new concepts to students' prior knowledge, the study seeks to offer evidence-based support for using advance organizers in secondary school Chemistry instruction.

Objectives of the Study

The objectives of the study are to determine:

1. the level of students' academic performance in redox-reaction concept taught using advanced organizer and those taught redox-reaction concept without using advance organizer in chemistry among senior secondary schools in Borno State.
2. the difference in the academic performance between students taught redox-reaction concept in chemistry using advanced organizer and students taught without using advance organizer in senior secondary schools in Borno State.
3. the difference in the academic performance of male and female students taught using advanced organizer in redox-reaction concept in chemistry and students taught without using advance organizer among senior secondary school students in Borno State.
4. the difference in retention of male and female students taught using advance organizer in redox-reaction concept in chemistry in senior secondary schools in Maiduguri Metropolis, Borno State.

Research Question

1.What is the level of students' academic performance in redox-reaction concept taught using advance organizer and those taught redox-reaction concept without using

advance organizer in chemistry among senior secondary schools in Borno State?

Research Hypotheses

The following hypotheses were tested at 0.05 level of significant:

H_{01}: There is no significant difference in academic performance between students taught redox-reaction concept in chemistry using advanced organizer and students taught without using advance organizer in senior secondary schools in Borno State.

H_{02}: There is no significant difference in academic performance of male and female students taught using advanced organizer in redox-reaction concept in chemistry and students taught without using advance organizer among senior secondary school students in Borno State.

H_{03}: There is no significant difference in retention between male and female students taught using advance organizer in redox-reaction concept in chemistry in senior secondary schools in Maiduguri Metropolis, Borno State.

Methodology

The research design adopted in this study was a quasi-experimental research design namely, non-equivalent control group pre-test, post-test and postpost-test design. The design was thought to be suitable since one could not randomly assign individual students but rather made use of intact classes. The entire senior secondary school students in the state of Borno, Nigeria, formed the population of the study. A multistage sampling method was used in selecting a sample of 365 students. The sample was made up of 4 functioning classes that were selected among secondary schools and their total numbered to 148 male students and 217 female students. The experimental group and the control group were assigned two intact classes each to keep the natural classroom environment and not to disrupt the school activities.

Data was collected using a Redox Reaction performance Test (RRPT) which was developed by a researcher. The instrument is validated by specialists in the field of Chemistry teaching and measurement and evaluation, and the reliability of the instrument is determined with the help of pilot research with the help of a specific coefficient of reliability. The two groups were given a pre-test to establish their initial equivalence prior to treatment. Experimental group was instructed on redox reactions through Advance Organizer approach that the control group was instructed through the traditional lecture approach. A post-test was done at the end of the instructional time to gauge the academic performance of the students and a subsequent retention test was done to gauge the retention. Data was analyzed by the mean and standard deviation to answer research questions and the hypotheses were tested by the independent sample t -test which was applied at 0. 05 level of significance.

Results

Research Question: What is the level of students' academic performance in redox-reaction concept taught using advanced

organizer and those taught redox-reaction concept without using advance organizer in chemistry among senior secondary schools in Borno State?

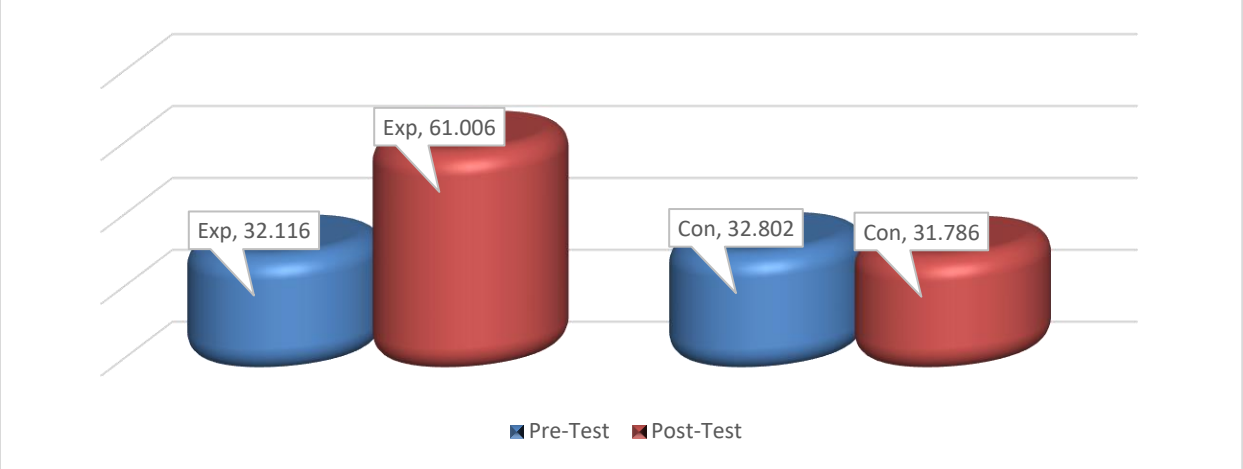


Figure 1: Level of students' academic performance in redox-reaction concept

Figure 1 presents the level of students' academic performance in redox-reaction concept in Chemistry for both the experimental and control groups. The figure shows that at the pre-test stage, the performance levels of students in both groups were relatively similar (Exp = 31.16, Con=32.80), indicating that the two groups were academically comparable before the commencement of the treatment. This suggests that there was no initial advantage of one group over the other prior to the introduction of the instructional strategy. However, at the post-test stage, the figure shows that, students in the experimental group (mean = 61.01) performed better than those in the control group (mean = 31.79).

Hypothesis One: There is no significant difference in academic performance between students taught redox-reaction concept in chemistry using advanced organizer and students taught without using advance organizer in senior secondary schools in Borno State.

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Table 1: Independent sample t-test on difference in academic performance between experimental and control groups

Group	N	Mean	SD	Df	T	p-value	Remark
			Pre-Test				
Experimental	173	32.12	6.50	363	-1.029	0.304	NS
Control	192	32.80	6.23				
			Post-Test				
Experimental	173	61.01	14.82	363	23.878	0.000	S
Control	192	41.79	12.61				

Table 1 presents the summary of independent sample t-test on difference in academic performance between students taught redox-reaction concept in chemistry using advanced organizer and students taught without using advance organizer in senior secondary schools in Borno State. Results revealed that, there was no significant difference in the pre-test mean scores of students in the experimental group (M = 32.12, SD = 6.50) and control group (M = 32.80, SD = 6.23), t = -1.029, p > 0.05. However, at post-test, a significant difference was observed between the experimental group (M = 61.01, SD = 14.82) and control group (M = 41.79, SD = 12.61), t = 23.878, p < 0.05. This indicates that the use of advanced organizer significantly improved students' academic performance in redox-reaction concept. Therefore, hypothesis one is rejected.

Hypothesis Two: There is no significant difference in academic performance of male and female students taught using advanced organizer in redox-reaction concept in chemistry and students taught without using advance organizer among senior secondary school students in Borno State.

Table 2: Independent sample t-test on difference in academic performance between male and female students when taught redox reaction concept using advance organizer

Gender	N	Mean	SD	Df	t	p-value	Remark
Male	141	46.70	18.24	363	.870	0.385	NS
Female	224	44.97	18.58				

Table 2 presents the summary of independent sample t-test on difference in academic performance between male and female students when taught redox-reaction concept in chemistry using advanced organizer in senior secondary schools in Borno State. Results revealed that, there was no significant difference in the mean scores of male students (M = 46.70, SD = 18.24) and female students (M = 44.97, SD = 18.58), t = 0.870,

p > 0.05. This indicates that the use of advanced organizer improved the academic performance of both male and female students equally. Therefore, hypothesis two is accepted.

Hypothesis Three: There is no significant difference in retention between male and female students taught using advance organizer in redox-reaction concept in chemistry in senior secondary schools in Maiduguri Metropolis, Borno State.

Table 3: Independent sample t-test on difference in academic retention between male and female students when taught redox reaction concept using advance organizer

Gender	N	Mean	SD	df	t	p-value	Remark
Male	73	64.03	11.81				
				171	.774	0.440	NS
Female	100	62.58	12.37				

Table 3 presents the summary of independent sample t-test on difference in academic retention between male and female students when taught redox-reaction concept in chemistry using advanced organizer in senior secondary schools in Maiduguri Metropolis, Borno State. Results revealed that, there was no significant difference in the retention mean scores of male students (M = 64.03, SD = 11.81) and female students (M = 62.58, SD = 12.37), t = 0.774, p > 0.05. This implies that both male and female students retained the redox-reaction concept equally when taught using advanced organizer. Therefore, hypothesis three is accepted.

Conclusion

Based on the findings of this study, it can be concluded that the use of advanced organizer is an effective instructional strategy for improving students' academic performance in redox-reaction concept in chemistry among senior secondary school students in Borno State. The study established that students taught using advanced organizer performed significantly better than those taught using the conventional method. Since there was no significant difference between the groups at the pre-test stage, the improvement observed at the post-test stage can be attributed to the treatment effect of the advanced organizer strategy. The study further concluded that the use of advanced organizer is gender-friendly, as no significant difference was found between male and female students in both academic performance and retention. This implies that the strategy provides equal learning opportunities and benefits to students irrespective of gender. The findings showed that advanced organizer enhances not only students' immediate academic achievement but also their retention of redox-reaction concepts. Therefore, the strategy promotes meaningful learning and long-term understanding of chemistry concepts. In view of these findings, it is concluded that advanced organizer is a valuable instructional approach that can be effectively integrated into the teaching of chemistry to improve students' performance and retention without gender bias.

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