

Impact of Concept Mapping as a Pedagogical Strategy on Chemistry Achievement of Senior Secondary II Learners in Enugu East, Nigeria

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Publication Date: 2026/08/20

Abstract: This study examined the influence of concept mapping pedagogy on Senior Secondary School II (SS II) learners' achievement in Chemistry in Enugu East Local Government Area, Enugu State, Nigeria. The study adopted a quasi-experimental pre-test, post-test control group design replicated in four public secondary schools. A total of 200 SS II Chemistry students (100 experimental, 100 control) participated. The experimental groups were taught selected topics (Atomic Structure, Periodic Table, Chemical Bonding, Acids, Bases and Salts) using concept mapping, while control groups were taught same topics using traditional lecture method for four weeks. Instrument was Chemistry Achievement Test (CAT) comprising 40 multiple-choice items (KR-20 = 0.82). Data were analyzed using mean, standard deviation, mean gain and ANCOVA at 0.05 level of significance. Results showed that students taught with concept mapping had significantly higher post-test scores ($M = 87.23$, $SD = 2.79$) than those taught with traditional method ($M = 62.42$, $SD = 4.51$). Mean gains for experimental groups ranged from 27.20 to 35.14 compared to 4.94 to 6.20 for control groups across the four schools. ANCOVA result was significant, $F(1,197) = 156.42$, $p < 0.001$. The study concluded that concept mapping is an effective learner-centered strategy for improving achievement, conceptual understanding and retention in Chemistry.

Keywords: Concept Mapping, Chemistry Achievement, Traditional Method, Senior Secondary, Enugu.

How to Cite: Iyase Amaka Evangeline (2026) Impact of Concept Mapping as a Pedagogical Strategy on Chemistry Achievement of Senior Secondary II Learners in Enugu East, Nigeria. *International Journal of Innovative Science and Research Technology*, 11(8), 1190-1192. <https://doi.org/10.38124/ijisrt/26aug537>

I. INTRODUCTION

Chemistry plays a crucial role in socio-economic and technological development, providing foundation for medicine, engineering, and agriculture. However, performance of secondary school students in Chemistry remains poor in Enugu Educational Zone, with WASSCE pass rates below 50% between 2015-2021. This has been attributed to abstract nature of concepts such as chemical bonding, stoichiometry and thermodynamics, dominance of rote memorization and teacher-centered methods (Okebukola, 2002), and negative attitudes towards the subject. Concept mapping approach, introduced by Novak and Gowin (1984) and anchored on Ausubel's theory of meaningful learning, organizes knowledge using nodes and linking phrases to depict interrelationships among concepts. Studies (Nesbit & Adesope, 2006; Barak & Dori, 2005) show it improves comprehension, retention and problem-solving, especially in science. Despite evidence, its use in Nigerian secondary schools remains limited due to lack of training and

resources (Okoye & Onah, 2015). This study therefore examined its effect on achievement in Enugu East LGA.

➤ Objectives of The Study

- To determine the effect of concept mapping on students' academic achievement in Chemistry.
- To compare the mean gain of students taught with concept mapping and those taught with traditional method.
- To ascertain if there is significant difference in achievement between the two groups.

II. METHODOLOGY

Research Design: Quasi-experimental pre-test, post-test control group design replicated across four schools. Area: Enugu East LGA, Enugu State, Nigeria. Population: All public SS II Chemistry students in Enugu East. Sample: Purposive sampling of four schools with qualified Chemistry teachers and functional labs. In each school, two intact classes were randomly assigned to experimental ($n = 25$) and control

(n = 25). Total sample = 200 students (100 experimental, 100 control). Instrument: Chemistry Achievement Test (CAT) – 40 multiple-choice items from SS II syllabus (Atomic Structure, Periodic Table, Chemical Bonding, Acids, Bases and Salts). Validated by three experts in Science Education and Measurement. Reliability via pilot test of 30 students, KR-20 = 0.82. Procedure: Pre-test administered to both groups. Four-week intervention using prepared lesson plans

and concept map templates. Experimental groups constructed concept maps individually and in small groups. Control groups received lecture method with chalkboard and textbook. Post-test administered under same conditions. Data Analysis: Mean, standard deviation, mean gain and Analysis of Covariance (ANCOVA) using pre-test as covariate, at $p < 0.05$.

III. RESULTS

Table 1 Pre-Test and Post-Test Mean Scores by School

School	Group	N	Pre-test M (SD)	Post-test M (SD)	Mean Gain
CSS Ugwogo Nike	Experimental	25	55.20 (3.51)	82.40 (2.58)	27.20
CSS Ugwogo Nike	Control	25	54.53 (4.41)	59.47 (4.41)	4.94
CSS Umuchigbo	Experimental	25	56.47 (3.42)	84.13 (2.94)	27.66
CSS Umuchigbo	Control	25	56.13 (4.43)	62.27 (4.43)	6.14
Annunciation Nkwo Nike	Experimental	25	57.67 (3.58)	88.53 (2.85)	30.86
Annunciation Nkwo Nike	Control	25	57.20 (4.58)	63.40 (4.58)	6.20
Girls Sec. Abakpa	Experimental	25	58.73 (3.35)	93.87 (2.23)	35.14
Girls Sec. Abakpa	Control	25	58.33 (4.59)	64.53 (4.59)	6.20

Table 2 Summary of Mean Scores Across Four Schools (N=200)

Group	N	Pre-test M (SD)	Post-test M (SD)	Overall Mean Gain
Experimental (Concept Mapping)	100	56.77 (3.46)	87.23 (2.79)	30.47
Control (Traditional)	100	56.55 (4.47)	62.42 (4.51)	5.86

Table 1 shows that in all four schools, experimental groups had higher post-test scores and larger mean gains (27.20 – 35.14) compared to control groups (4.94 – 6.20). Table 2 shows overall experimental mean gain of 30.47 vs 5.86 for control.

ANCOVA result: $F(1,197) = 156.42$, $p < 0.001$, indicating significant difference in favour of concept mapping. Effect size (Cohen's $d = 2.85$) showed large practical effect.

IV. DISCUSSION OF FINDINGS

Objective 1 – Effect on Academic Achievement: The significant improvement in post-test scores of experimental groups ($M = 87.23$) compared to control ($M = 62.42$) shows that concept mapping has a positive effect on achievement. This aligns with Ausubel's theory of meaningful learning – when new concepts (e.g., ionic vs covalent bonding) are linked visually to prior knowledge (atoms, electrons), understanding deepens. This supports findings of Bello and Tijani (2013) on stoichiometry and Okebukola (2022). Objective 2 – Comparison with Traditional Method: Traditional lecture method produced only marginal gains (5.86), confirming literature that rote memorization fails to address abstract chemistry concepts (Johnstone, 1991). Concept mapping's low standard deviation (2.79 vs 4.51) suggests it helped both high and low achievers, reducing disparity – important for large Nigerian classrooms. Objective 3 – Significant Difference: The large effect size ($d = 2.85$) and consistent pattern across four different school environments show the result is not due to school location but the instructional strategy itself. The use of pre-made maps,

blank templates, and group construction promoted active participation, ownership and peer discussion (Kinchin et al., 2000; Nwagbo & Chukelu, 2011), which are absent in lecture method. Challenges Observed: Field notes revealed initial challenges – students took extra time to learn map construction, and materials (chart paper, markers) were scarce. Teachers needed brief training to avoid turning maps into mere notes-copying exercise. These align with Okoye and Onah (2015) and Ezenwa and Nwachukwu (2018) on barriers to innovative strategies in Nigeria.

V. CONCLUSION AND RECOMMENDATIONS

Based on findings, concept mapping significantly enhances SS II students' achievement in Chemistry in Enugu East LGA. It is more effective than traditional lecture method for teaching abstract topics.

➤ Recommendations:

- Chemistry teachers in Enugu State should adopt concept mapping as regular instructional strategy.
- Enugu State Ministry of Education and Post Primary Schools Management Board should organize workshops to train teachers on construction and use of concept maps.
- Curriculum planners and Colleges of Education should integrate concept mapping into methodology courses.
- Further research should develop a Chemistry Attitude Scale to measure affective outcomes and investigate retention over 3-6 months.

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