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Empirical Paper

Effect of Note-Taking on Academic Achievement Among Senior Secondary School Chemistry Students in Katsina Metropolis, Nigeria

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Abstract

Purpose: This study examined the effect of note-taking on the academic achievement of Senior Secondary School Chemistry students in Katsina Metropolis and determined whether male and female students with complete note-taking practices differed significantly in achievement.

Methodology: An ex-post facto research design was adopted. The population comprised 12,163 Senior Secondary School II (SS II) Chemistry students in public secondary schools in Katsina Metropolis. A sample of 384 students (186 males and 198 females) was selected using multistage sampling. Data were collected using a researcher-developed Note-Taking Assessment Checklist (NTAC), while academic achievement was obtained from Chemistry continuous assessment records. Mean and standard deviation were used to answer the research questions, while independent samples t-tests tested the hypotheses at the 0.05 significance level.

Results: Students with complete note-taking practices achieved significantly higher scores ($M = 68.74$, $SD = 9.86$) than those with incomplete practices ($M = 56.91$, $SD = 11.72$), $t(382) = 10.61$, $p = .001$. No significant difference was found between male ($M = 69.42$, $SD = 9.41$) and female ($M = 68.12$, $SD = 10.24$) students with complete note-taking practices, $t(226) = 0.99$, $p = .324$.

Novelty and Contribution: The study provides empirical evidence that complete note-taking practices are associated with improved Chemistry achievement and that their effectiveness does not differ by gender, extending evidence from Nigerian secondary schools.

Practical and Social Implications: Chemistry teachers should teach and reinforce effective note-taking skills. Structured note-taking can improve achievement, support active learning, and provide equitable learning opportunities for male and female students.

Keywords: Academic Achievement, Chemistry Education, Ex-post Facto Design, Gender, Note-taking

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1 Introduction

Education is widely recognised as a fundamental instrument for national development because it promotes knowledge acquisition, human capital development, innovation, and social transformation. Effective education also equips learners with the competencies required to solve societal problems and adapt to emerging scientific and technological advancements. Science education plays a central role in developing scientifically literate citizens capable of making informed decisions, solving real-world problems, and contributing to sustainable national development (UNESCO, 2021). Within science education, Chemistry occupies a strategic position because it provides the conceptual foundation for medicine, agriculture, engineering, environmental management, and numerous industrial applications. Despite its importance, Chemistry remains one of the most challenging science subjects for many secondary school students due to the abstract nature of chemical concepts and the need to integrate macroscopic, submicroscopic, and symbolic representations simultaneously (Taber, 2019).

Within the teaching and learning process, students' use of appropriate learning strategies plays a crucial role in determining academic success. Among these strategies, note-taking has consistently been identified as an effective learning practice that supports active engagement during classroom instruction (Morehead et al., 2019). The research argues that, rather than serving merely as a written record of classroom activities, note-taking encourages learners to select, organise, and synthesise important information, thereby facilitating deeper cognitive processing and long-term retention of knowledge (Morehead et al., 2019). This indicates that students who employ effective note-taking strategies may demonstrate superior comprehension, memory, and academic performance compared with students who rely solely on listening during instruction. Moreover, research in chemistry education has consistently shown that many learners develop alternative conceptions and misconceptions that hinder conceptual understanding unless effective instructional strategies are deliberately employed (Taber, 2019). Consequently, chemistry education research increasingly emphasises learner-centred instructional approaches and effective learning strategies that actively engage students in constructing scientific knowledge and improving academic achievement, among which note-taking is included.

Note-taking is a strategic learning activity through which students record, organise, and synthesise important information presented during instruction for subsequent review and reflection. The process involves more than simply transcribing classroom content; it requires learners to identify key ideas, integrate new information with prior knowledge, and construct meaningful representations of concepts, thereby promoting deeper learning (Carroll, 2024). Furthermore, effective note-taking encourages metacognitive regulation by helping learners monitor their understanding, identify knowledge gaps, and prepare more efficiently for assessments (Carroll, 2024). These cognitive and metacognitive benefits make note-taking an indispensable study strategy, particularly in subjects that require sequential conceptual understanding such as Chemistry.

Chemistry learning requires students to study and understand abstract concepts, solve quantitative problems, and relate symbolic representations to observable phenomena. Consequently, student-centred learning strategies that actively engage learners during classroom instruction have been widely recommended to improve conceptual understanding and academic achievement (Okwuduba & Okigbo, 2018). It cannot be argued that findings from chemistry education research further indicate that instructional approaches promoting active participation, collaborative learning, and self-regulated study habits significantly enhance students' achievement compared with traditional teacher-centred methods. Although some studies have reported differences in learning experiences and motivation between male and female students, recent research suggests that achievement differences are influenced more by instructional quality, learning environment, and students' academic beliefs than by gender itself (Fink et al., 2018; Vincent-Ruz et al., 2018).

Academic achievement refers to the extent to which learners attain the intended educational objectives after a period of instruction and is commonly measured through classroom tests, examinations, and other standardised assessment procedures (OECD, 2023). In Chemistry education, academic achievement reflects students' understanding of scientific concepts, problem-solving abilities, and the application of theoretical knowledge to practical situations (Taber, 2019). Studies conducted by Morehead et al. (2019) have shown that students who employ effective learning strategies, including note-taking, self-regulated learning and active engagement during classroom instruction, tend to achieve higher academic outcomes than those who adopt passive learning approaches. Similarly, Dunlosky et al. (2013) identified practice testing, distributed practice, and effective note-taking as among the learning strategies that

consistently improve students' academic performance across different educational settings. Consequently, promoting the idea that effective note-taking habits may contribute substantially to improving students' achievement in secondary school Chemistry.

Gender has remained an important variable in science education research because male and female students may differ in learning experiences, motivation, classroom participation and study habits. However, findings on gender differences in academic achievement have remained inconsistent across studies. While some studies have reported slight differences in favour of either male or female students depending on the learning setting, others have found no statistically significant differences when students receive similar instructional opportunities and employ effective learning strategies (OECD, 2023). In Chemistry education specifically, for instance, Vincent-Ruz et al. (2018) suggest that instructional quality, students' self-efficacy and classroom learning experiences are stronger predictors of achievement than gender alone. Fakhri and Ahmed (2025) reported that the Cornell Note-Taking Strategy significantly improved secondary school students' systematic thinking skills, highlighting the role of organised note-taking in promoting meaningful learning and cognitive engagement. These varied findings indicate the need for further empirical investigation into whether gender moderates the relationship between note-taking and students' academic achievement in Chemistry among senior secondary school students in Katsina Metropolis.

Statement of the Problem

In the 2024 West African Senior School Certificate Examination (WASSCE), 1,805,216 candidates sat for the examination, with 1,301,941 (72.12%) obtaining credits in at least five subjects, including English Language and Mathematics. Similarly, the National Examinations Council (NECO) reported that 1,376,423 candidates registered for the 2024 Senior School Certificate Examination (SSCE), of whom 828,284 (60.55%) obtained five credits, including English Language and Mathematics. Despite these overall improvements, the WAEC and NECO Chief Examiners' Reports continued to identify weaknesses in candidates' understanding of fundamental Chemistry concepts, chemical calculations, practical skills, and scientific reasoning. These persistent challenges have been attributed to ineffective instructional practices, inadequate learning resources, low student engagement and poor study habits, including ineffective note-taking, thereby necessitating the investigation of effective learning strategies for improving students' achievement in Chemistry.

Among the various study habits that influence learning outcomes, note-taking has received considerable attention because of its role in facilitating active learning, improving information processing and enhancing long-term retention of knowledge (Morehead et al., 2019). Students who actively record, organise, and review classroom notes are generally more likely to develop meaningful understanding of scientific concepts than those who rely solely on listening during classroom instruction. However, classroom observations suggest that many secondary school students pay little attention to effective note-taking during Chemistry lessons, thereby limiting opportunities for meaningful learning and improved academic performance.

Although previous studies have established the educational benefits of note-taking, most of the available empirical evidence has been found to be from higher education settings or from studies conducted outside Nigeria. Furthermore, many Nigerian studies have focused primarily on innovative instructional strategies such as inquiry-based learning, cooperative learning, concept mapping, or technology-assisted instruction, while comparatively little attention has been devoted to students' routine note-taking practices during regular classroom instruction. Consequently, at the time this study was conducted, there was limited empirical evidence regarding the influence of note-taking on the academic achievement of senior secondary school students studying Chemistry in Katsina Metropolis, Nigeria.

Objectives of the Study

The study was guided by the following objectives:

i. To determine the effect of note-taking on the academic achievement of Senior Secondary School Chemistry students in Katsina Metropolis.

ii. To determine whether there is a difference in the academic achievement of male and female Chemistry students who practice note-taking in Katsina Metropolis.

Research Questions

The following research questions guided the study:

i. What is the mean academic achievement of students who practice complete note-taking and those who practice incomplete note-taking during Chemistry lessons?

ii. What is the difference in the mean academic achievement of male and female students who practice complete note-taking during Chemistry lessons?

Research Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H01: There is no significant difference in the mean academic achievement of students who practice complete note-taking and those who practice incomplete note-taking during Chemistry lessons.

H02: There is no significant difference in the mean academic achievement of male and female students who practice complete note-taking during Chemistry lessons.

2 Methodology

This study employed an Ex-post Facto (Causal-Comparative) research design to investigate the effect of note-taking on the academic achievement of Senior Secondary School II (SS II) Chemistry students in Katsina Metropolis. The design was considered appropriate because it examined the relationship between an existing independent variable (students' note-taking practices) and the dependent variable (academic achievement) without manipulating the independent variable. Since students' note-taking behaviours had naturally occurred before the commencement of the study, the researchers compared the academic achievement of students who consistently maintained complete Chemistry notes with those whose notes were incomplete or absent. The design therefore provided an appropriate framework for investigating naturally existing differences in academic achievement associated with students' note-taking practices.

The population of the study comprised 12,163 Senior Secondary School II (SS II) Chemistry students enrolled in public secondary schools in Katsina Metropolis during the 2025/2026 academic session. A multistage sampling technique was employed to select the study participants. In the first stage, six public secondary schools offering Senior Secondary School Chemistry were selected through simple random sampling (balloting without replacement) from the list of eligible public secondary schools in Katsina Metropolis. In the second stage, proportionate sampling was used to distribute the total sample of 384 students among the selected schools according to the population of SS II Chemistry students in each school. Consequently, the proportionately allocated sample comprised 58 students (28 males and 30 females) from School A, 66 students (32 males and 34 females) from School B, 61 students (30 males and 31 females) from School C, 64 students (31 males and 33 females) from School D, 70 students (34 males and 36 females) from School E, and 65 students (31 males and 34 females) from School F, giving a total sample of 384 SS II Chemistry students (186 males and 198 females). In the third stage, the proportionately allocated number of male and female students was selected from each participating school using simple random sampling (balloting without replacement). The official SS II class registers served as the sampling frame, ensuring that every eligible student had an equal opportunity to participate in the study.

Data were collected using a researcher-developed Note-Taking Assessment Checklist (NTAC). The NTAC consisted of 15 items distributed across six dimensions: completeness, organisation, accuracy, legibility, dating, lesson identification, and coverage of lesson content. Each item was rated on a 3-point scale: 2 = Adequately Demonstrated, 1 = Partially Demonstrated, and 0 = Not Demonstrated, with a maximum obtainable score of 30. Based on the total scores, students were classified as complete note-takers (21-30) or incomplete note-takers (0-20). Students' academic achievement was measured using their Chemistry Continuous Assessment (CA) scores obtained from official school records.

The NTAC was subjected to face and content validation by three experts, comprising two specialists in Chemistry Education and one specialist in Measurement and Evaluation from Umaru Musa Yar'adua University, Katsina. To establish the reliability of the instrument, a pilot study was conducted using 30 SS II Chemistry students from a

public secondary school outside the study area but possessing similar characteristics to the study population. Two trained assessors independently evaluated the students' notebooks using the checklist, and the resulting scores were analysed using the Intra-class Correlation Coefficient (ICC). The analysis yielded a reliability coefficient of 0.88, indicating a high level of agreement between the assessors and confirming that the instrument was sufficiently reliable for the study.

Before data collection commenced, an introductory letter was obtained from the Department of Science Education, Umaru Musa Yar'adua University, Katsina, while permission to conduct the study was obtained from the Katsina Zonal Education Quality Assurance (KZEQA) and the principals of the selected secondary schools. Thereafter, the researchers visited each selected school to assess students' Chemistry notebooks using the NTAC. Based on the assessment, students were categorised according to the completeness of their notes. Subsequently, the students' Chemistry continuous assessment scores were obtained from the official school records. The notebook assessment results and academic achievement scores were coded and compiled for statistical analysis. These scores served as the quantitative measure of students' academic achievement and were subsequently used to compare the achievement of students with complete and incomplete note-taking practices.

The collected data were coded, entered, and analysed using the Statistical Package for the Social Sciences (SPSS) version 23.0. Descriptive statistics comprising mean and standard deviation were used to answer the research questions. The corresponding formulated null hypotheses were tested using the Independent Samples t-test. All hypotheses were tested at the 0.05 level of significance.

In line with ethical research principles, confidentiality and anonymity were ensured by assigning identification codes in place of participants' names. All information obtained was treated confidentially and used solely for research purposes. The study posed no physical, psychological, or academic risk to the participants and did not disrupt normal school activities. Throughout the study, the researchers upheld the principles of honesty, objectivity, and integrity in the collection, analysis, interpretation and reporting of the findings.

3 Results

Table 1 Mean and Standard Deviation of Academic Achievement of Students with Complete and Incomplete Note-Taking Practices

Note-taking Practice	N	Mean	SD	Mean Difference
Complete Note-takers	228	68.74	9.86	
				11.83
Incomplete Note-takers	156	56.91	11.72	

Table 1 presents the mean and standard deviation of the academic achievement scores of students with complete and incomplete note-taking practices in Chemistry. The results indicate that 228 students were classified as complete note-takers, while 156 were classified as incomplete note-takers. Students with complete note-taking practices obtained a higher mean academic achievement score (M = 68.74, SD = 9.86) than those with incomplete note-taking practices (M = 56.91, SD = 11.72), resulting in a mean difference of 11.83 in favour of the complete note-takers. This finding suggests that students who maintained complete, well-organised notes achieved better academic performance in Chemistry than those with incomplete note-taking practices.

Table 2 Independent Samples t-test Comparing Academic Achievement of Students with Complete and Incomplete Note-Taking Practices

Note-taking Practice	N	Mean	SD	df	t	p	Decision
Complete Note-takers	228	68.74	9.86				
				382	10.61	0.001	Rejected
Incomplete Note-takers	156	56.91	11.72				

Table 2 presents the results of the Independent Samples t-test comparing the academic achievement of students with complete and incomplete note-taking practices in Chemistry. The results revealed a statistically significant difference between the two groups, t(382) = 10.61, p = .001. Since the p-value is less than the 0.05 level of significance, the null hypothesis was rejected. This implies that students who maintained complete note-taking practices achieved significantly higher academic performance in Chemistry than those with incomplete note-taking practices. The finding provides empirical evidence that effective note-taking is associated with improved academic achievement among senior secondary school Chemistry students.

Table 3 Mean and Standard Deviation of Academic Achievement of Male and Female Students with Complete Note-Taking Practices

Gender	N	Mean	SD	Mean Difference
Male	108	69.42	9.41	
				1.3
Female	120	68.12	10.24	

Table 3 presents the mean and standard deviation of the academic achievement scores of male and female students who maintained complete note-taking practices in Chemistry. The results show that 108 of the complete note-takers were males, while 120 were females. Male students obtained a slightly higher mean academic achievement score (M = 69.42, SD = 9.41) than their female counterparts (M = 68.12, SD = 10.24), resulting in a mean difference of 1.30 in favour of the male students. However, the small mean difference suggests that the academic achievement of male and female students who practised complete note-taking was largely comparable.

Table 4 Independent Samples t-test Comparing Academic Achievement of Male and Female Students with Complete Note-Taking Practices

Gender	N	Mean	SD	Df	t	p	Decision
Male	108	69.42	9.41				
					0.99	0.324	Retained
Female	120	68.12	10.24	226			

Table 4 presents the results of the Independent Samples t-test comparing the academic achievement of male and female students who maintained complete note-taking practices in Chemistry. The analysis revealed that there was no statistically significant difference in the mean academic achievement scores of male and female students, $t_{(226)}$ = 0.99, p = 0.324. Since the p-value is greater than the 0.05 level of significance, the null hypothesis was retained. This indicates that although male students recorded a slightly higher mean achievement score than female students, the observed difference was not statistically significant. The finding therefore suggests that effective note-taking contributes to improved academic achievement regardless of students' gender.

Summary of the Major Findings

The major findings of the study are as follows:

i. Students with complete note-taking practices achieved significantly higher academic performance in Chemistry than those with incomplete note-taking practices ($t_{(382)}$ = 10.61, p = .001).

ii. There was no statistically significant difference in the academic achievement of male and female students who maintained complete note-taking practices ($t_{(226)}$ = 0.99, p = .324), indicating that effective note-taking benefits both genders equally.

4 Discussion of Findings

The findings of this study revealed that students who maintained complete note-taking practices achieved significantly higher academic performance in Chemistry than those with incomplete note-taking practices. Specifically, students with complete notes obtained a significantly higher mean achievement score (M = 68.74, SD = 9.86) than students with incomplete notes (M = 56.91, SD = 11.72), with the observed difference being statistically significant ($t_{(382)}$ = 10.61, p = 0.001). This finding suggests that effective note-taking facilitates active engagement with classroom instruction, promotes meaningful processing and organisation of information, and enhances subsequent retrieval of learned concepts, thereby improving academic achievement. The finding supports the encoding-storage theory of note-taking, which posits that learning is enhanced through both the cognitive processing involved in recording information and the opportunity to review notes after instruction. The result corroborates the findings of Morehead et al. (2019), who reported that effective note-taking and subsequent review significantly improve students' learning, memory, and academic performance. Similarly, Kobayashi (2019), in a meta-analysis, concluded that note-taking exerts a positive effect on academic achievement by promoting deeper cognitive processing during instruction and providing an external storage resource for revision. The present finding is also consistent with Carroll (2024), who observed that structured note-taking improves metacognitive regulation, conceptual understanding, and examination performance. The present finding is further supported by Fakhri and Ahmed (2025), who investigated the effectiveness of the Cornell Note-Taking Strategy among second-year intermediate Chemistry students. Their quasi-experimental study found that students taught using the Cornell note-taking strategy demonstrated significantly higher systematic thinking skills than those taught using the conventional instructional method. Although the study examined systematic thinking rather than academic achievement, the findings suggest that structured note-taking enhances learners' cognitive organisation, information processing, and meaningful engagement with Chemistry concepts. This evidence complements the present study by demonstrating that effective note-taking contributes not only to higher-order thinking but also to improved academic achievement in Chemistry. Likewise, Udu and Mbamalu (2025) found that learner-centred instructional strategies that encourage active cognitive engagement significantly enhance students' achievement in Chemistry. Therefore, the significantly higher achievement recorded by students with complete note-taking practices in this study provides further empirical evidence that note-taking is an effective learning strategy for improving students' academic achievement in Chemistry.

The findings further revealed that there was no statistically significant difference in the academic achievement of male and female students who maintained complete note-taking practices. Although male students recorded a marginally higher mean achievement score (M = 69.42, SD = 9.41) than female students (M = 68.12, SD = 10.24), the difference was not statistically significant ($t_{(226)}$ = 0.99, p = .324). This finding indicates that the academic benefits of effective note-taking are comparable for both male and female students and suggests that note-taking enhances learning irrespective of gender. The result is consistent with Vincent-Ruz et al. (2018), who found that students' achievement in Chemistry is more strongly influenced by prior knowledge, self-efficacy, and learning experiences than by gender. It also agrees with the OECD (2023) PISA 2022 report, which concluded that differences in academic achievement between male and female students are largely shaped by learning opportunities, classroom experiences, and students' engagement rather than gender itself. Similarly, Udu and Mbamalu (2025) reported that learner-centred instructional approaches promoting active learning and self-regulation improved students' achievement irrespective of gender. Fink et al. (2018) likewise observed that students' motivation, study habits, and self-efficacy are stronger predictors of academic performance than gender differences. The present finding therefore suggests that when students adopt effective note-taking practices, both male and female learners are equally likely to experience improved academic achievement in Chemistry, underscoring the importance of promoting note-taking skills among all students regardless of gender.

5 Conclusion and Recommendations

This study concluded that effective note-taking significantly enhances students' academic achievement in Chemistry. Students who maintained complete note-taking practices performed significantly better than those with incomplete notes. The study also found no significant difference in the academic achievement of male and female students who practised effective note-taking, indicating that the strategy benefits both genders equally. Based on these findings, it is recommended that Chemistry teachers explicitly teach and reinforce effective note-taking skills during classroom

instruction. Schools should also encourage students to develop consistent note-taking habits, while curriculum developers and educational stakeholders should integrate note-taking strategies into the teaching and learning of Chemistry and other science subjects.

Practical and Social Implications

The findings provide empirical evidence that effective note-taking is a simple, low-cost, and learner-centred strategy for improving students' academic achievement in Chemistry. The study highlights the need for teachers to incorporate structured note-taking activities into classroom instruction to promote active learning and self-regulated study habits. Since the strategy benefits both male and female students equally, its implementation can foster equitable learning opportunities, improve students' academic success, and strengthen the quality of science education in secondary schools.

Limitations of the Study

The study was limited to public senior secondary schools in Katsina Metropolis, thereby restricting the generalisability of the findings to other educational contexts. Furthermore, the ex-post facto research design did not permit the establishment of a causal relationship between note-taking practices and students' academic achievement. The assessment of note-taking was also based on students' notebooks, which may not have captured all aspects of their note-taking behaviours.

Future Research Directions

Future studies should replicate this research in different geographical locations and include both public and private secondary schools to enhance the generalisability of the findings. Researchers should also employ experimental or quasi-experimental designs to establish the causal effects of note-taking on students' academic achievement. In addition, future studies should investigate the effectiveness of different note-taking strategies, such as guided, Cornell, generative and digital note-taking, on students' achievement, retention, and other learning outcomes in Chemistry.

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Data Availability Statement

Data are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no competing interests.

Declaration of Generative AI Use

Generative AI tools were used only for language editing, grammar, clarity, and formatting, not for study conceptualisation, methodology, analysis, or interpretation. The authors take full responsibility for the manuscript's content.

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