



Impact of PowerPoint-Based Instructional Modes on Secondary School Students' Performance in Chemistry Achievement Test (CAT) in Obudu, Cross River State, Nigeria

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ABSTRACT

Background: The quest to enhance students' performance in Chemistry has led to increased interest in innovative instructional strategies such as the use of information and communication technologies (ICTs) in teaching and learning. One of such is PowerPoint-based instruction mode. Meanwhile the impact of this mode of instruction on students' achievement in Chemistry has remained largely underexplored.

Objective: This study examined impact of PowerPoint-based instructional modes on secondary school students' performance in Chemistry Achievement Test (CAT) in Obudu Local Government Area of Cross River State, Nigeria.

Method: Quasi-experimental design was employed and the simple random sampling technique adopted in drawing four secondary schools from the twenty-eight public secondary schools that make up the Obudu Local Government Area for the study of which 114 SS II students were used as sample from a population of 2,009 SS II students. Data were collected using Chemistry Achievement Test (CAT) with a reliability coefficient of 0.87, determined using KR-20. The mean and standard deviation were used to answer three research questions while ANCOVA was used to test three hypotheses that guided the study at 0.05 level of significance.

Results: The findings of the study revealed that the mean achievement scores of students taught Chemistry using PowerPoint modes was higher than the mean achievement scores of students taught with the Lecture Method. This difference is statistically significant at $p < 0.05$. Female students had higher mean achievement scores than the male students when taught using PowerPoint modes. The difference is however statistically non-significant at $p < 0.05$. Also, there is no significant interaction effect of teaching method and gender on students' mean achievement scores in Chemistry at $p < 0.05$.

Unique Contributions: This study provides fresh insights showing that PowerPoint-Based Instructional Modes offer clearer presentation, improved visualisation, and better conceptual representation of chemistry concepts leading to improved students' academic achievement in Chemistry.

Conclusion: The study concludes that PowerPoint-Based instructional modes is superior to the lecture method in facilitating secondary school students' achievement in Chemistry.

Key Recommendation: Teachers should sufficiently expose students to visual learning materials, digital simulations, and multimedia-enhanced explanations to strengthen their comprehension of chemistry concepts and processes.

Keywords: PowerPoint modes, gender, Interaction effect, Chemistry Achievement Tests (CAT)



INTRODUCTION

Education remains a fundamental driver that enables individuals to adapt to societal changes and achieve progress in science and technology. Within the Senior Secondary curriculum, chemistry is a pivotal science subject, yet many students perceive it as abstract and difficult. This perception often results in poor concept retention and weak academic achievement, particularly among Senior Secondary Class Two (SSII) learners who are developing essential foundational knowledge for external assessments (Okorie, 2022). With advancements in educational technology, digital tools have increasingly demonstrated potential in enhancing learning experiences. Among these tools, PowerPoint presentations provides multiple channels for delivering content such as visuals, audio support, animations, and interactive components, thereby, accommodating diverse learning preferences. Effective instructional strategies are essential for sustaining students' interest and improving academic outcomes, and visual aids like PowerPoint have become widely used for these purposes. In subjects such as chemistry, where learners must grasp complex ideas, PowerPoint can support clearer explanations and improve comprehension (Mensah, 2023).

PowerPoint, now installed on hundreds of millions of computers globally, is a presentation platform that allows users to arrange text and images on sequential slides for projection or printing. The software functions as more than a traditional tool; it shapes how presenters are evaluated because it serves as a communicative medium that influences audience perception (Harrington, 2018). Recent digital innovations have produced several PowerPoint formats, including standard slideshows, multimedia-based presentations, and interactive layouts that integrate videos, animations, and demonstrations. These formats can correspond with varied learning styles, thereby enhancing students' ability to recall information and improving their academic success (Benson, 2020). Despite the widespread use of PowerPoint in schools, limited research has examined how different presentation modes influence chemistry students' achievement. For SS2 learners—an important stage in their educational pathway—understanding the most effective teaching methods is vital for immediate success and sustained interest in science-related fields.

Presentation software is among the most accessible educational tools in classrooms, enabling teachers and students to create overheads, slides, handouts, and speaker notes within a single file. Engaging with such technology encourages active participation in learning. Examples of presentation software include Microsoft PowerPoint, Adobe Persuasion, and Delta Graph Pro (Nwoke, 2021). As technology integration continues to transform instructional practices, PowerPoint's diverse presentation modes, ranging from text and images to animations and interactive features, offer opportunities to increase engagement and strengthen students' achievement.

Since SSII students are preparing for major examinations and future academic choices, identifying effective strategies that promote achievement in chemistry is increasingly important. This need is heightened in contexts where educational challenges persist. PowerPoint has



become a widely adopted instructional tool because of its ability to organize content visually and interactively. Multimedia presentations support the dual-coding theory, which posits that learners understand better when information is presented both verbally and visually (Morris, 2021). Likewise, incorporating visuals such as images and animations improves conceptual understanding compared to text-only lessons (Douglas & Lane, 2016). PowerPoint enhances classroom instruction by allowing teachers to emphasize key concepts and embed multimedia elements including video clips, audio resources, and hyperlinks, making lessons more dynamic and accessible (Adeyemi, 2021).

Different PowerPoint modes also support effective teaching. Normal View assists teachers in designing and editing slides; Slide Show Mode presents ideas in a sequential and coherent manner; Presenter View helps instructors manage time and navigate content; Outline View facilitates lesson planning; and Reading View allows quick content review. These modes collectively enhance teacher efficiency and student engagement during lessons (Khalid, Turner, & Scott, 2017).

In chemistry instruction, PowerPoint is particularly valuable because it helps students visualize difficult concepts such as molecular structures, chemical bonding, and reaction mechanisms. Visual tools make abstract processes more concrete and comprehensible (Ajayi, 2017). Integrating animation and chemical simulations has been shown to improve learners' understanding of reaction processes and periodic trends (Ogunleye & Patrick, 2019). Additional multimedia elements, such as laboratory videos and color-coded equations, can also stimulate interest. However, the effectiveness of PowerPoint relies on sound design practices, as overly crowded slides or excessive effects may hinder learning rather than support it (Morris & Bello, 2019).

Academic achievement represents the measurable outcome of teaching and learning and reflects how well students accomplish stated educational objectives. It is assessed through tests, observations, and other performance indicators (Chikwe, 2016). Academic success is typically evaluated by examining how well learners complete tasks or achieve expected standards (Opara, 2019). Against this background, the study examined the impact of powerpoint-based instructional modes on secondary school students' performance in Chemistry Achievement Test (CAT) in Obudu Local Government Area of Cross River State, Nigeria.

Chemistry is a vital science subject in the senior secondary school curriculum, yet many SSII students continue to demonstrate low academic achievement due to difficulties in understanding its abstract concepts (Okorie, 2022). In response, educators have increasingly adopted PowerPoint-based instructional modes to enhance learning through visual, auditory, and interactive elements consistent with multimedia learning theory (Douglas & Lane, 2016; Morris, 2021). However, despite widespread classroom use, most existing studies have examined PowerPoint as a general teaching aid without systematically comparing students' achievement under PowerPoint-based instruction and the conventional lecture method, particularly in chemistry classrooms (Mensah, 2023). In addition, empirical evidence remains inconclusive



regarding gender differences in students' achievement when PowerPoint-based modes are employed, as well as the interaction effects between instructional method and gender. Many previous studies were conducted in different subject areas, educational levels, or geographical settings, thereby limiting their applicability to SSII chemistry students in Nigerian secondary schools. This lack of comparative, gender-sensitive, and context-specific research constitutes a notable gap in the literature, necessitating the present study to examine differences in mean achievement scores between students taught chemistry using PowerPoint-based modes and those taught through the lecture method, assess gender-related differences in achievement, and determine the interaction effect of teaching method and gender on secondary school students' academic achievement in chemistry in Obudu Local Government Area of Cross River State.

RESEARCH QUESTIONS

The following research questions guided the study:

1. What is the mean achievement scores of students taught Chemistry with PowerPoint-Based modes of instruction and those taught using lecture method?
2. What is the mean achievement scores of male and female students taught Chemistry using PowerPoint-Based modes of instruction?
3. What is the interaction effect of teaching method and gender on students' mean achievement scores in Chemistry?

RESEARCH HYPOTHESES

The following research hypotheses guided the study at the 0.05 level of significance:

- 1 There is no significant difference in the mean achievement scores of students taught Chemistry with PowerPoint-Based modes of instruction and those taught using lecture method.
- 2 There is no significant difference in the mean achievement scores of male and female students taught PowerPoint-Based modes of instruction.
- 3 There is no significant interaction effect of teaching method and gender on students' mean achievement scores in Chemistry.

METHOD

Study design: This study was conducted using a quasi-experimental pre-test, post-test control group design.

Setting: The research area for this study was Obudu Local Government Area of Cross River State, Nigeria.

Study population and sampling strategy: The population of the study consists of all SS II students in public secondary schools in Obudu Local Government Area. As at the time of this study, there were twenty-eight (28) public secondary schools and the study population stood at two thousand and nine (2009) SS II students. The researcher simple randomly drew four



secondary schools from the 28 public secondary schools that made up the study area for the study. Two secondary schools for the experimental group and two secondary schools for the control group, making a total of four secondary schools. The researcher then used intact classes (i.e. students present in class at the time of the research) of the sampled schools for the study, comprised of 114 SS II students (45 males and 69 females).

Data collection and management: The Chemistry Achievement Test (CAT) designed by the researcher from Chemistry textbooks (SS 2) was the instrument used for data collection. The achievement test consisted 20-item multiple choice questions from the lessons taught to test the achievement of students with one key and three distractors. A marking scheme was prepared and each correct option in the multiple tests attracted 1 point. The test items were drawn based on Bloom's taxonomy of educational objectives and the purpose of this study using a table of specification based on the content of the lesson taught.

Data analysis: The descriptive statistic of Mean and Standard deviation was used to answer the research questions while the hypotheses were tested at the 0.05 level of significance using the ANCOVA.

RESULTS

Research Question One

What is the mean achievement scores of students taught Chemistry with PowerPoint-Based modes of instruction and those taught using lecture method?

The Chemistry Achievement Test (CAT) was administered to the treatment and control groups and data obtained were used to answer this research question. Summary of results obtained for the two groups is shown in Table 1

Table 1: Mean Achievement Scores of Students taught Chemistry with PowerPoint modes and those taught using lecture method

Methods	N	Mean (\bar{X})	Standard deviation
Powerpoint modes	49	22.79	4.86
Lecture Method	65	15.98	4.76

Source: Researcher's Compilation, 2025

From Table 1 it can be observed that the experimental group had a mean achievement score of 22.79 and a standard deviation of 5.59 while the control group had a mean achievement score of 15.98 and a standard deviation of 6.50. The mean achievement scores of students taught using the Powerpoint modes was greater than the mean achievement scores of students taught using the Lecture method. Thus, the Powerpoint modes is superior to the lecture method in facilitating students' achievement in Chemistry.



Research Question Two

What is the mean achievement scores of male and female students taught PowerPoint-Based modes of instruction?

The Chemistry Achievement Test (CAT) was administered to the treatment and control groups and data obtained were used to answer this research question. Summary of results obtained for the two groups is shown in Table 2

Table 2: Mean Achievement Scores of Male and Female Students taught Chemistry using PowerPoint modes

Gender	N	Mean (\bar{X})	Standard deviation
Male	33	22.57	5.49
Female	14	23.85	3.99

Source: Researcher’s compilation, 2025

From Table 2 it can be observed that the male students had a mean achievement score of 22.57 and a standard deviation of 5.49 while the female students had a mean achievement score of 23.85 and a standard deviation of 3.99. The result therefore shows that the female students performed better than the male students in Chemistry using powerpoint modes.

Research Question Three

What is the interaction effect of teaching method and gender on students’ mean achievement scores in Chemistry?

The Chemistry Achievement Test (CAT) was administered to the treatment and control groups and data obtained were used to answer this research question. Summary of results obtained for the two groups is shown in Table 3

Table 3: Interaction effects between teaching methods and gender on students’ mean achievement in Chemistry

Method	Gender					
	Male			Female		
	N	\bar{X}	SD	N	\bar{X}	SD
Powerpoint modes	33	22.57	5.47	14	23.85	3.99
Lecture method	17	17.11	6.44	48	15.58	6.55

Source: Researcher’s Compilation, 2025

From Table 3 it can be observed that the mean achievement scores for the female students was higher than that of the male students in the experimental group while the mean achievement scores for the male students was higher than that of the female students in the control group.



Hypothesis One

There is no significant difference in the mean achievement scores of students taught Chemistry with PowerPoint-Based modes of instruction and those taught using lecture method.. This hypothesis was tested using the Analysis of Covariance (ANCOVA) statistical techniques. The results of data analysis are presented in Table 4.

Table 4: ANCOVA for Students’ Chemistry Achievement Scores by Teaching Method

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1301.295 ^a	2	650.648	17.172	.000
Intercept	8449.708	1	8449.708	223.004	.000
Pretest	5.116	1	5.116	.135	.714
Method	1270.122	1	1270.122	33.521	.000
Error	4205.828	111	37.890		
Total	46282.000	114			
Corrected Total	5507.123	113			

Significant at $p < 0.05$

Source: Researcher’s Compilation, 2025

For hypothesis 1, the alpha level (0.05) is greater than the significance of F (0.000), therefore, the researcher rejects the null hypothesis and concludes that there is significant difference in the mean achievement scores of students taught Chemistry with PowerPoint modes and those taught using lecture method.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female students taught Chemistry using PowerPoint-Based modes of instruction. This hypothesis was tested using the Analysis of Covariance (ANCOVA) statistical techniques. The results of data analysis are presented in Table 5.

Table 5: ANCOVA for Students’ Chemistry Achievement Scores by Gender using Powerpoint modes

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	16.140 ^a	1	16.140	.619	.436
Intercept	21193.161	1	21193.161	812.500	.000
Gender	16.140	1	16.140	.619	.436
Error	1173.775	45	26.084		
Total	25961.000	47			
Corrected Total	1189.915	46			

Not Significant at $p < 0.05$

Source: Researcher’s Compilation, 2025

For hypothesis 2, the alpha level (0.05) is less than the significance of F (0.436), therefore, the researcher accepts the null hypothesis and concludes that there is no significant difference in the mean achievement scores of male and female students taught Chemistry using powerpoint modes.



Hypothesis Three

There is no significant interaction effect of teaching method and gender on students' mean achievement scores in Chemistry. This hypothesis was tested using the Analysis of Covariance (ANCOVA) statistical techniques. The results of data analysis are presented in Table 6.

Table 6: ANCOVA for Students' Chemistry Achievement Scores by Method and Gender

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1368.727 ^a	3	456.242	12.127	.000
Intercept	37348.849	1	37348.849	992.745	.000
Method	72.063	1	72.063	1.915	.169
Gender	977.210	1	977.210	25.975	.000
Method * Gender	.789	1	.789	.021	.885
Error	4138.396	110	37.622		
Total	46282.000	114			
Corrected Total	5507.123	113			

Not Significant at $p < 0.05$

Source: Researcher's Compilation, 2025

For hypothesis 3, the alpha level (0.05) is less than the significance of F (0.067), therefore, the researcher accepts the null hypothesis and concludes that there is no significant interaction effect of teaching method and gender on students' mean achievement scores in word problems in algebra.

DISCUSSION

Research question 1 sought to determine the effect of PowerPoint-Based modes of instruction on students' achievement in Chemistry. Results relating to this research question were presented in Table 1 in Chapter Four. Students who were taught using the PowerPoint modes had higher mean achievement scores than those taught using the Lecture method. Test of hypothesis showed that there was a significant difference in the mean achievement scores of students taught Chemistry with PowerPoint modes and those taught with the lecture method. The achievement mean scores were not equivalent. This implies that the difference between the achievement mean scores was systematic and not due to chance occurrence. The PowerPoint instructional mode is therefore a very good teaching method that can be used to enhance students' academic achievement in Chemistry. The higher achievement mean score of the students taught using PowerPoint modes may be due to the visual supports, animations, illustrations, and structured sequencing of ideas which helped to make abstract Chemistry concepts clearer and more meaningful. The visual representations provided by the PowerPoint slides may have increased students' attention and comprehension of key concepts, leading to improved achievement in the posttest. The interactive and engaging nature of multimedia instruction also makes learning more interesting and reduces cognitive load, thereby enabling students to answer the questions asked at the end of the lesson with greater ease.



These findings agree with studies such as Effiom and Abdullahi (2021); Haruna (2019); and Tyoor and Musa (2022), who observed that students exposed to innovative, student-centered instructional strategies such as problem-solving or multimedia-based approaches had higher achievement than those exposed to the traditional lecture method. These researchers also recommended that teachers should be trained through seminars and workshops on the effective use of modern teaching strategies for classroom instruction. Similarly, Aduwa (2021) noted that students taught with interactive instructional strategies performed significantly better than those taught using the lecture method. Hence, the use of PowerPoint and other multimedia strategies is effective for teaching science concepts and should be adopted as a regular classroom instructional approach. On the contrary, Likita (2023) observed that there was no significant difference in the mean achievement scores of students taught using innovative teaching techniques and those taught with the conventional method in algebra. However, such contrary findings may be due to differences in sample characteristics, teachers' competence, or implementation fidelity of the innovative.

Research question 2 sought to determine the mean achievement scores of male and female students taught Chemistry using PowerPoint-Based modes of instruction. Results relating to this research question were presented in Table 2 in Chapter Four. Female students who were taught using PowerPoint modes had a slightly higher mean achievement score (23.85) than their male counterparts who recorded a mean score of 22.57. This suggests that, descriptively, female students performed better than male students when exposed to the PowerPoint instructional strategy. Test of hypothesis, however, showed that there was no significant difference in the mean achievement scores of male and female students taught Chemistry using PowerPoint modes. The achievement mean scores were therefore considered equivalent. This implies that the difference between the achievement mean scores of male and female students was not systematic, but rather due to chance occurrence. Thus, PowerPoint modes may be regarded as a gender-friendly instructional method capable of enhancing students' academic achievement in Chemistry irrespective of whether they are male or female. The similarity in achievement may be due to the fact that PowerPoint presentations rely heavily on visual representations, structured content, and multimedia features that appeal to different learning styles. These features reduce gender-related achievement gaps by providing equal opportunity for both male and female learners to process, interpret, and retain information. Visual aids, animations, and guided explanations inherent in PowerPoint slides make abstract Chemistry concepts more concrete and accessible to all students, thereby promoting uniform achievement levels.

These findings are consistent with prior research such as Aduwa (2021) that reported no significant gender differences when modern, student-centered, or technology-enhanced instructional strategies are used. Such studies suggest that when learning environments are interactive, clearly illustrated, and supportive, gender disparities tend to diminish. However, some empirical findings have shown slight variations in favor of either males or females depending on the subject area or teaching method. These inconsistencies may be attributed to factors such as sample size, classroom dynamics, teacher delivery style, and learners' prior knowledge. Nevertheless, the finding from this study reinforces the notion that PowerPoint



modes support learning equitably across gender lines. Hence, Chemistry teachers can confidently adopt multimedia-based instructional strategies without concern for gender-based achievement disadvantages. The present study contributes to the body of knowledge by reinforcing evidence that PowerPoint-based modes can reduce gender disparities in Chemistry achievement, supporting their adoption as equitable instructional tools in secondary school science classrooms.

Research question 3 sought to determine the interaction effect of teaching method and gender on students' mean achievement scores in Chemistry. Results relating to this research question were presented in Table 3 in Chapter Four. The findings revealed that within the experimental group (students taught using PowerPoint modes), the female students had higher mean achievement scores than their male counterparts. Conversely, in the control group (students taught using the lecture method), the male students had higher mean achievement scores than the female students. This pattern suggests some descriptive variations in achievement across method and gender categories. However, the test of hypothesis showed that there was no significant interaction effect of teaching method and gender on students' mean achievement scores in Chemistry. The interaction mean scores were not statistically different. This implies that the observed differences between the achievement scores across gender and teaching method occurred by chance and were not systematic. Therefore, neither gender nor method jointly influenced students' achievement in a way that created a combined effect. Both males and females responded similarly to the instructional methods used, indicating that teaching method did not favor one gender over the other in any meaningful or consistent manner. The absence of a significant interaction effect suggests that PowerPoint modes and lecture methods operate independently of gender when influencing students' achievement in Chemistry. This may be attributed to the fact that both male and female students can benefit equally from organized instructional materials, whether presented through technology-based approaches or traditional teaching methods. In particular, the structure and clarity provided by PowerPoint slides may reduce gender-related differences by simplifying content presentation and enhancing comprehension for all learners.

These findings agree with Ogunleye and Adeyemi (2020) who reported that teaching method and gender did not jointly influence students' achievement in science subjects, noting that modern instructional strategies tend to narrow gender gaps in achievement. Similarly, Eze and Okoro (2022) found no significant interaction effect between gender and instructional method when technology-based approaches were used in teaching Chemistry, emphasizing that both male and female learners benefit equally from multimedia-supported instruction. The result of this study reinforces the conclusion that teaching method and gender do not combine to significantly influence achievement in Chemistry. By confirming these findings within the context of Chemistry instruction at the SSII level, the present study extends existing research by providing localized empirical evidence that multimedia instructional strategies such as PowerPoint can be implemented without concern for differential gender outcomes, thereby supporting inclusive and effective teaching practices.



CONCLUSIONS

The study concluded that the PowerPoint-Based modes of instruction is superior to the Lecture method in facilitating students' achievement in Chemistry. It showed that there is a significant difference in the mean achievement scores of students taught using PowerPoint modes and those taught using the Lecture method. Also, the study concluded that the PowerPoint instructional mode is effective for students of both genders, meaning that there is no significant interaction between method and gender on students' achievement in Chemistry. Thus, the PowerPoint mode enhances students' achievement irrespective of gender and can be adopted as an efficient instructional strategy for teaching Chemistry concepts.

Ethical Clearance

Ethical consent was sought and obtained from the principals of the schools used in this study. They were made to understand that the exercise was purely for academic purposes, and their participation was voluntary.

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Conflict of interest

The authors declare no competing interests.

Authors' contributions

Abasiama Hope Idorenyin was the principal investigator who conceptualized the study and research design, developed the protocol, Anongo Claudette Omaku performed data collection, and wrote the initial draft, subsequently revising the manuscript. Abasiama Endurance Alorye participated in the study's conceptualization and write-up.

Availability of data and materials

The data supporting the study's conclusion are accessible from the corresponding author upon reasonable request

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