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# POTENCY OF EXAMPLE-BASED APPROACH ON STUDENTS' ACADEMIC ACHIEVEMENT AMONG SENIOR SECONDARY STUDENTS IN MALUMFASHI, KATSINA STATE, NIGERIA

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## Abstract

*This study investigates the effectiveness of example-based approach on students' academic achievement among senior secondary school students in Malumfashi, Katsina State, Nigeria, with a focus on both the main effect and gender differences. The study was guided by two research questions and two corresponding hypotheses. The study adopted quasi-experimental design. The study engaged 179 out of the total population of 2,452 Senior Secondary School 2 Chemistry students. The sample size was obtained from four intact classes which were also obtained from four coeducational public secondary schools, purposively sampled from 27 schools in Malumfashi Zonal Education Quality Assurance. Two groups of mixed-gender were established; experimental group taught chemistry concepts using the example-based approach and control group taught the same concepts with conventional lecture method for the duration of six weeks. A validated, WAEC-adapted Chemistry Achievement Test (CAT) was used to assess the students' academic achievement, having reliability coefficient of 0.87. All research questions were answered using the mean and standard deviation while, ANCOVA was used to test null hypothesis one and Independent sampled t-test was used to test null hypothesis two at 0.05 level of significance. The results of the study indicated a significant main effect, with the experimental group outperforming the control group ($p<0.05$), but no significant gender difference was observed ($p>0.05$). Based on the results, it was concluded that example-based approach enhances students' understanding of Chemistry concepts, benefiting both male and female students equally. Recommendations include integrating example-based strategies into the Chemistry curriculum, ensuring gender-sensitive teacher training in science education.*

**Keywords**: Example-based approach, Academic Achievement, Chemistry, Senior Secondary Schools, Students.

## Introduction

Science and technology play an indispensable role in transforming secondary education in Nigeria, offering tools and approaches that make learning more dynamic, practical, and relevant to everyday life. Through interactive methods for instance, students are better equipped to understand complex concepts and apply them in solving real-world problems. In essence, twenty-first century science education fosters essential

competencies such as critical thinking, effective problem-solving, and sound decision-making. These skills are crucial for preparing students to engage with complex global challenges and contribute meaningfully to sustainable development (Gencer & Doğan, 2020).

As schools increasingly adopt science-based learning strategies, the importance of subject-specific focus becomes more apparent. In this regard, chemistry is a fundamental science subject crucial for understanding natural phenomena and supporting technological advancements. It stands out as a central pillar, enabling learners to explore the composition of matter, environmental issues, health solutions, and industrial applications, thereby connecting science education directly to Nigeria's developmental goals. However, its abstract concepts often challenge secondary school students, leading to poor academic performance (Johnstone, 2019). In Nigeria, the West African Examinations Council (WAEC) reported that only 49.7% of candidates achieved credit passes in Chemistry (WAEC, 2023, NBS, 2024). Consequently, students' underachievement in chemistry is frequently attributed to ineffective teaching methods and approaches in the teaching and learning process. It is therefore important to determine teaching approach suitable to learners during a lesson and in this context the use of innovative strategies and approaches in the teaching of chemistry such as example example-based approach.

Example-based Approach (EBA) is an instructional strategy that emphasizes the use of worked examples or concrete illustrations to guide students in learning new concepts, skills, or problem-solving procedures. This method helps learners internalize abstract ideas by observing step-by-step demonstrations, thereby reducing cognitive load and improving comprehension, especially in complex subjects like mathematics and science. In essence, the EBA is based on the fact that teaching is sort of example. The use of relevant examples cater for different learners' different experiences. The amount of examples highlighted in a particular lesson increases the tendency for higher understanding the concept taught. This approach was grounded in cognitive load theory, uses worked examples to reduce cognitive overload and promote schema acquisition (Sweller et al., 2019). By providing step-by-step solutions, this method helps students focus on understanding processes rather than trial-and-error problem-solving (Renkl, 2014). While the approach has been effective in subjects like Mathematics and Physics (Van Gog & Kester, 2012), similar result is expected when applied in Chemistry teaching-learning process. Additionally, gender differences in science education have been a topic of interest, with some studies suggesting that instructional strategies may impact male and female students differently due to socio-cultural factors and learning preferences (Okebukola, 2021). Hence, understanding whether the example-based approach benefits both genders equally is crucial for ensuring equitable education at secondary school level. This study evaluates the potency of example-based approach on students' academic achievement among senior secondary school students in Malumfashi Zonal Education, Katsina State, Nigeria, with a focus on both the main effect of the teaching method and potential gender differences.

Theoretically**,** this study is grounded in cognitive load theory (CLT), which asserts that instructional design should optimize working memory capacity to enhance learning

(Sweller et al., 2019). CLT identifies three types of cognitive load: intrinsic, extraneous, and germane. The example-based approach minimizes extraneous load by presenting structured solutions, allowing students to allocate cognitive resources to germane load, which supports knowledge construction (Paas & Sweller, 2016). Additionally, self-determination theory (SDT) supports this approach, as engaging instructional methods like worked examples can enhance intrinsic motivation and self-efficacy, potentially benefiting both male and female students by addressing their unique motivational needs (Ryan & Deci, 2020).

Empirically, studies highlighted the effectiveness of example-based learning in science education. For instance, a study by Van Gog and Kester (2018) found that students who learned Physics through worked examples outperformed those using traditional problem-solving methods, demonstrating improved conceptual understanding and problem-solving skills. Similarly, Hoogerheide et al. (2019) reported that example-based learning enhanced Chemistry students' ability to solve organic chemistry problems by reducing cognitive overload and fostering deeper engagement with the material. However, these studies did not explore gender differences, which this study aims to address by examining whether the approach benefits male and female students equally. Chemistry education in Nigeria faces significant challenges, including ineffective teaching methods, limited instructional resources, and low student motivation (Okebukola, 2021). The conventional lecture method often fails to address students' misconceptions or promote active learning, leading to poor academic outcomes (Taber, 2019).

Gender disparities also persist, with female students sometimes underperforming in Chemistry due to socio-cultural factors, such as limited encouragement to pursue science, and teaching methods that may not cater to their learning styles (Okebukola, 2021). The example-based approach, with its structured and interactive nature, may help address these gender-related challenges by providing equal opportunities for engagement and understanding. Furthermore, few studies focus on Chemistry education at the SSS 2 level, where students encounter challenging topics like stoichiometry and organic chemistry. Additionally, there is a lack of research on how example-based learning impacts gender differences in Chemistry achievement. This study addresses these gaps by investigating the efficacy of the example-based approach in a rural Nigerian context and examining its effects on both male and female students.

**Statements of the Problem**

The persistent poor achievement of students in Chemistry within Malumfashi Zonal Education is a pressing concern. According to the Katsina State Ministry of Education (2023), only 45% of SS2 students in Malumfashi achieved a passing grade in Chemistry during the 2022/2023 West African Examination Council (WAEC, 2024) academic session, compared to the state average of 52%. This under-achievement is attributed to the abstract nature of Chemistry concepts, the predominant use of the conventional lecture method, and a lack of instructional strategies that address students' cognitive challenges (Taber, 2019). The conventional method, which emphasizes teacher-centered instruction and rote memorization, often fails to engage students or facilitate

deep understanding of topics such as stoichiometry, chemical bonding, and organic chemistry, which are foundational for SS2 students (Okebukola, 2021).
Without intervention, this trend of encouraging achievement may limit students' ability to pursue science-related careers, perpetuating educational and economic disparities in the region. Moreover, gender disparities in science education are still concern in Nigeria, with some studies indicating that female students may underperform in Chemistry due to socio-cultural factors, such as limited encouragement to pursue science, and teaching methods that do not address their learning needs (Okebukola, 2021). Therefore, the example-based approach, which relies primarily on teacher-led worked examples and minimal resources, is well-suited to this context, making the study highly relevant (Adesoji & Olatunbosun, 2021). Example-based approach has shown promise in other settings for improving academic outcomes by reducing cognitive load and enhancing conceptual understanding (Renkl, 2014). In this regard, this study aimed examining whether the example-based approach can significantly improve SS2 Chemistry students' academic achievement compared to the conventional lecture method, and whether its effects differ by gender.

## Objectives of the Study

The objectives of the study were to:

1. Determine the main effect of the example-based approach on the academic achievement of SS2 Chemistry students compared to the conventional lecture method.
2. Examine the effect of the example-based approach on the academic achievement of SS2 Chemistry students with respect to gender.

## Research Questions

To guide the study, the following research questions were formulated:

1. What is the mean score difference in academic achievement of chemistry students taught chemistry concepts with example-based approach and those taught the same concepts using conventional lecture method?
2. Is there any mean score difference in academic achievement of male and female chemistry students taught chemistry concepts with example-based approach?

## Research Hypotheses

The following null hypotheses were tested at a 0.05 significance level:
**$Ho_1$:** There is no significant difference in the mean score academic achievement of chemistry students taught chemistry concepts with example-based approach and those taught the same concepts using conventional lecture method.
**$Ho_2$:** There is no significant difference in the mean score academic achievement of male and female chemistry students taught chemistry concepts with example-based approach.

## Methodology

A quasi-experimental, pre-test, post-test control group design was adopted. This design is suitable for educational settings where random assignment is impractical (Creswell & Creswell, 2018). This provide an avenue to use intact classes for the study to avoid the disruption of the normal structure of seconders school classroom. The design also allowed for the comparison of academic achievement between the experimental and control groups while also examining gender differences within each group. The independent variables was teaching with example-based approach while the dependent variables was academic achievement.

The population comprised 2,452 Senior Secondary School 2 (SSS2) Chemistry students across 27 public secondary schools in Malumfashi Zonal Education Quality Assurance. A purposive sampling technique was used to select four co-educational schools based on accessibility of the school location. From these schools, 179 students form the sample size for the study. These students comprised of an intact class of 95 (40 male and 55 females) students which were randomly assigned as experimental group and an intact class of 84 (33 male and 51 females) students which were randomly assigned as control group. The gender labeling is to enable the study to address the objective of examining whether the example-based approach benefits male and female students differently or otherwise.

A WAEC-adapted Chemistry Achievement Test (CAT) was used to measure academic achievement. The CAT consisted of 50 multiple-choice questions covering SSS2 Chemistry topics (e.g., chemical bonding, stoichiometry, and organic chemistry). The instrument's reliability was established using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.87, indicating high reliability. Content validity was confirmed by two expert in chemistry. They also reviewed the test for potential gender bias.

To collect the relevant data for the study, the researcher visited the schools, sought permission to undertake the study and to use the school chemistry teachers in the school for the study. In each school selected, chemistry teacher taught the experimental and control groups. To control for teachers' effect, teachers were trained in different locations. The four-week treatments session covered contents on the following concepts: chemical bonding, stoichiometry and organic chemistry. The total period of the study was six weeks. The first week was allocated for training of research assistants and pre-test of both the experimental and control groups using CAT. Teaching in the two groups using lesson plans organized using Example-based-Teaching Approach Sequence of Instruction (Figure 1) and conventional lecture method commenced in the second week and lasted for four weeks.


**Figure 1. Example-based-Teaching Approach Sequence of Instruction**
**Source:** Adapted from Renkl (2014) and Sweller et al. (2019)

The utilization of students' class teachers was due to the believed that it could help control Hawthorne effect. Both groups were taught by the same teacher to control for instructor bias. The teacher were trained to ensure that the delivery of the example-based approach was gender-sensitive, using examples that were relatable to both male and female students which are familiar to both genders. After the teaching, post-test was administered to the two groups during the sixth week. Students' gender was recorded to enable gender-based analysis. Scores obtained were analyzed using descriptive statistics and inferential statistics. Research questions one and two were answered using mean and standard deviation, whereas, null hypotheses one and two were tested using ANCOVA and Independent sample t-test respectively. Both analyses were conducted at a 0.05 significance level using SPSS version 20 on *Windows 10 Pro*.

## Results

### Answers to Research Questions

**Research Question One:** What is the mean score difference in academic achievement of chemistry students taught chemistry concepts with example-based approach and those taught the same concepts using conventional lecture method?

**Table 1 Descriptive Analysis of Posttest Scores of Experimental and Control Groups**

| Group | N | Mean | SD | Mean Difference |
|---|---|---|---|---|
| **Experimental** | 95 | 36.15 | 9.048 | |
| | | | | 13.97 |
| **Control** | 84 | 22.18 | 8.160 | |

Table 1 shows that, the students taught chemistry concepts using example-based approach have (M = 36.15 and SD = 9.05) whereas the students taught chemistry concepts using conventional lecture method have (M = 22.18 and SD = 8.16). This gives the mean academic achievement difference of 13.97 in favour of the experimental group which clearly shows that students taught chemistry concepts using example-based approach have high mean achievement scores than those taught same concept using conventional lecture method.

**Research Question Two:** Is there any mean score difference in academic achievement of male and female chemistry students taught chemistry concepts with example-based approach?

**Table 2 Descriptive Analysis of Posttest Scores of Experimental Group by Gender**

| Group | Gender | N | Mean | SD | Mean Difference |
|---|---|---|---|---|---|
| | **Male** | 33 | 32.36 | 6.99 | |
| **Experimental** | | | | | 3.31 |
| | **Female** | 51 | 35.67 | 4.17 | |

Table 2 shows descriptive analysis of posttest scores of experimental group by gender. It revealed that, in the experimental group, male students have (M = 32.36 and SD = 6.99) while, female students have (M = 35.67 and SD = 4.17). This gives the mean difference of 3.31 in favour of female students. It shows that the mean achievement of male students was descriptively higher compared to female counterpart when taught chemistry concepts with example-based approach.

**Hypotheses Testing**

**$Ho_1$:** There is no significant difference in the mean score academic achievement of chemistry students taught chemistry concepts with example-based approach and those taught the same concepts using conventional lecture method.

**Table 3. Results of ANCOVA of Chemistry Students' Academic Achievement in the Experimental and Control Groups**

*Dependent Variable: Posttest Scores*

| Sources of Variance | Sum of Squares | df | Mean Square | F | *p*-value | Decision |
|---|---|---|---|---|---|---|
| **Corrected model** | 770.328a | 2 | 385.164 | 5.153 | .007 | |
| **Intercept** | 12182.798 | 1 | 12182.798 | 163.004 | .000 | |
| **Pretest** | 68.117 | 1 | 68.117 | .911 | .341 | |
| **Groups (Treatment)** | 708.472 | 1 | 708.472 | 9.479 | 0.002 | Significant |
| **Error** | 13154.141 | 176 | 74.739 | | | |
| **Total** | 224331.000 | 179 | | | | |
| **Corrected Total** | 13924.469 | 178 | | | | |

a. R Squared = .055 (Adjusted R Squared = .045)

Table 3 showed the summary of Analysis of Covariate (ANCOVA) of chemistry students' academic achievement in the experimental and control groups. The result indicated that the F-ratio of 9.48 with associated *p*-value of 0.002. Since the associated *p*-value of .001 was less than 0.05 level of significance, the null hypothesis one was rejected and the alternative hypothesis accepted. This means, there was significant difference in the mean score academic achievement of chemistry students taught chemistry concepts with example-based approach and those taught the same concepts using conventional lecture method.

**$Ho_1$:** There is no significant difference in the mean score academic achievement of male and female chemistry students taught chemistry concepts with example-based approach.

**Table 4. Results of Independent-Sampled t-test of Male and Female Chemistry Students' Academic Achievement in the Experimental Group**

| Group | Gender | N | Mean | SD | t | df | *p* | Decision |
|---|---|---|---|---|---|---|---|---|
| **Experimental** | **Males** | 33 | 31.36 | 6.99 | 1.19 | 82 | 0.17 | Insignificant |
| | **Females** | 51 | 35.67 | 4.17 | | | | |

Table 4 shows results of independent-sampled t-test of male and female chemistry students' academic achievement in the experimental group. It indicates that the observed difference in Table 2 was not significant since the calculated *p*-value of 0.17 is greater than the critical value of 0.05 level of significance. Therefore, the null hypothesis two was accepted and alternative rejected. Hence, there was no significant difference in the mean score academic achievement of male and female chemistry students taught chemistry concepts with example-based approach.

## Summary of the Major Findings

i. Findings indicate descriptive and significant difference in the mean score academic achievement of chemistry students taught chemistry concepts with example-based approach and those taught the same concepts using conventional lecture method.
ii. It also shows descriptive but insignificant difference in the mean score academic achievement of male and female chemistry students taught chemistry concepts with example-based approach.

## Discussion of the Findings

The findings confirm the effectiveness of the example-based approach in improving the academic achievement of SSS2 Chemistry students in Malumfashi Zonal Education aligned with a finding Hoogerheide et al. (2019), who establish that worked examples enhance Chemistry students' understanding of complex concepts. The success of this approach may be attributed to its ability to reduce cognitive load, allowing students to focus on learning processes rather than extraneous problem-solving (Sweller et al., 2019). This is particularly impactful in students often struggle with abstract Chemistry concepts due ineffective teaching methods (Taber, 2019).

The lack of a significant gender effect is a key finding, suggesting that the example-based approach benefits both male and female students equally. This contrasts with some studies that report gender disparities in Chemistry achievements, often attributing female under-achievement to socio-cultural factors such as limited encouragement to pursue science (Okebukola, 2021). The equitable impact of the example-based approach may be due to its structured and interactive nature, which aligns with self-determination theory by fostering intrinsic motivation and engagement for all students (Ryan & Deci, 2020). The use of gender-neutral examples and mixed-gender collaborative activities during the intervention likely helped address potential barriers for female students, such as lower confidence in science subjects. Additionally, the teacher's gender-sensitive delivery, such as encouraging equal participation in discussions, may have contributed to this outcome.

## Conclusion

It can be concluded that, the example-based approach significantly enhances the academic achievement of SSS2 Chemistry students in Malumfashi Zonal Education, with no significant gender differences in its effect. By reducing cognitive load and fostering active engagement, the approach addresses challenges associated with traditional teaching methods and promotes equitable learning outcomes for both male and female students. The findings underscore the potential of the example-based approach as a gender-inclusive strategy that can bridge achievement gaps in Chemistry education.

## Recommendations

Based on these findings, it can be recommended that:

1. Example-based strategies should be integrated into the Nigerian Chemistry Curriculum to enhance student achievement across diverse settings, ensuring that the approach is implemented in a gender-sensitive manner to benefit both male and female students equally.
2. Chemistry teachers should be trained on designing and implementing worked examples, with a focus on gender-sensitive pedagogy. Training should include strategies to encourage equal participation, such as using gender-neutral examples and fostering collaborative learning environments that empower female students in science.

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