Effect of Animated and Static Infographic Instructional Materials on Students' Academic Performance in Isomerism in Chemistry

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0118

Received: 13 February 2025; Accepted: 21 February 2025; Published: 26 March 2025

ABSTRACT

The study was carried out to examine the effect of animated and static infographic instructional materials on students' academic performance in isomerism in Chemistry in Mkpat Enin Local Government Area. Two research questions and two hypotheses were formulated to guide the study. The design for the study was quasi-experimental design. The population of this study comprised all the 1846 Senior Secondary one (SS2) Chemistry students in the sixteen (16) public secondary schools in the study area during the 2023/2024 session. The sample size for this study was 87 Chemistry students. Simple random sampling technique was used in selecting two public co-educational secondary schools in the study area and in each of the selected schools an intact class of SS2Chemistry students was used for the study. The instrument used for data collection was "Chemistry Performance Test on Isomerism (CPTI)". The instrument was subjected to face and content validity by two Chemistry education lecturers and an expert in Measurement and Evaluation in the Department of Science Education, Akwa Ibom State University. A reliability coefficient of .85 was obtained for the instrument using Kuder-Richardson formula-20. Data were analyzed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results showed that students taught the concept of isomerism using animated infographic instructional materials performed significantly better than those taught using static infographics. The findings also showed no significant difference in the mean performance scores between male and female Chemistry students. Based on the findings of the study, it was recommended among others that Chemistry teachers should use animated infographic instructional materials in teaching isomerism; seminars and workshops should be organized to train teachers on the use of animated infographic instructional materials in teaching isomerism and organic chemistry concepts.

Keyword: Animated, Static, Infographic instructional materials, Isomerism, Academic Performance

INTRODUCTION

Science serves as the foundation for human progress, enabling a deeper understanding of the natural world. It drives technological innovation, addresses complex societal challenges, and empowers humanity to develop sustainable solutions for the future. Among the many branches of science, Chemistry plays a significant role as the "central science," bridging the physical, biological, and environmental sciences. It provides insights into molecular and atomic structures that govern the behaviour of matter and energy (Umanah & Etiubon, 2022).

Chemistry influences a wide range of fields, including medicine, energy generation,, agriculture, and environmental preservation. For instance, the principles of Chemistry underpin the development of pharmaceuticals, the creation of sustainable energy solutions, and the formulation of fertilizers. Chemistry is indispensable in industries such as food processing, textiles, cosmetics, petrochemicals, and metallurgy (Gongden, 2016). Studying Chemistry is essential for equipping the next generation with the knowledge and skills needed to tackle global challenges. It not only provides students with scientific knowledge but also fosters critical thinking and problem-solving skills crucial for various career opportunities (Umanah & Sunday, 2022).

Chemistry is often perceived as one of the challenging subjects for secondary school students, leading to persistent underachievement in examinations. This challenge is evident in the consistent poor performance in the West African Senior School Certificate Examination (WASSCE). Reports from the West African Examination Council (WAEC, 2022, 2023, 2024) have highlighted the persistent underachievement in Chemistry, raising concerns about the adequacy of instructional delivery. Some of the factors contributing to this poor performance include the abstract nature of Chemistry and difficult concepts such as chemical bonding, thermodynamics, chemical equilibrium, isomerism, among others. Furthermore, other factors include inappropriate teaching methods, lack of well-equipped laboratories, inadequate utilization of instructional materials, and student-related variables (Ajayi & Ogbeba, 2017; Umanah & Sunday, 2022).

To address these challenges, researchers have emphasized the need for innovative instructional materials, which can simplify complex concepts and enhance student academic performance (Anthony & Andala, 2023; Obikezie, Abumchukwu & Chikendu, 2021). Samuel (2025) opined that instructional materials are the various tools, materials and technologies used by the teacher to support teaching and learning. Arop, Umanah and Effiong (2015) described instructional materials as essential tools that facilitate effective teaching and learning by making abstract concepts tangible and relatable. They help to bridge the gap between theoretical knowledge and practical application, by providing visual, interactive and hands-on experiences, thereby improving students' comprehension and retention (Arop, Umanah & Effiong, 2015). Chikendu (2022) and Arop and Umanah (2014) stated that instructional materials play a pivotal role in the teaching-learning process in Chemistry by enhancing comprehension, motivation, fostering engagement, and improving students' learning outcomes. Ezeliora, Ibe and Obikezie (2021) affirmed that utilizing appropriate instructional materials improves students' understanding of concepts and retention of knowledge leading to better academic performance in Chemistry compared to teaching without instructional materials.

One of the abstract and challenging concepts in Chemistry is isomerism in organic Chemistry. Isomerism is a fundamental phenomenon where two or more compounds share the same molecular formula but differ in their structural or spatial arrangements of atoms, leading to distinct chemical and physical properties (Clark, 2023). It is categorized into structural isomerism (where the connectivity of atoms differs) and stereoisomerism (where the spatial orientation varies). The compounds exhibiting this phenomenon are called isomers. Understanding isomerism requires students to visualize molecular structures, identify spatial arrangements, and recognize how different forms of the same molecular formula exhibit distinct properties. The use of traditional methods alone without appropriate instructional materials makes it difficult for the students to understand the concept of isomerism.

The traditional method of teaching Chemistry, which relies heavily on text-based explanations and chalkboard illustrations, is inadequate in enhancing students' active engagement and conceptual understanding (Umanah & Babayemi, 2024). This approach often fails to address the abstract nature of concepts like isomerism, which requires visualization and interactive learning. Consequently, there is a growing need to integrate innovative and technology-driven instructional materials that can simplify complex concepts, promote student engagement, and enhance conceptual visualization, understanding, and retention of knowledge, particularly for abstract topics that require deeper cognitive processing (Itighise, 2016).

There are various innovative and interactive visual-based instructional materials that have the ability to simplify abstract concepts as well as enhance students' conceptual understanding and academic achievement. One of such innovative instructional materials is infographics, which are visual representations of information designed to simplify complex ideas and improve comprehension (Afify, 2018; Ozdamli & Ozdal, 2018; Al-Mohammdi, 2017; Yildirim, 2016). Infographics combine text, images, and symbols to present information in a visually appealing and structured manner, making them effective for teaching challenging concepts like isomerism (Boco, Miralles & Malindog, 2020; Al-Behadili & Al-Dayni, 2022). By leveraging visualization, infographics can bridge the gap between theoretical knowledge and practical application, providing students with a clearer understanding of molecular structures and spatial arrangements. They help to transform volumes of information into a comprehensible picture to the students (Ukpai & Fomsi, 2017). Infographics can categorized into animated infographics (dynamics, moving visuals) and static infographics (stationary, non-moving visuals). Both types of infographics leverage on visualization but their effects on student learning may differ. This makes infographics effective teaching tools, as they help students engage with content in a way that promotes deeper understanding and critical thinking skills (Ismaeel & Al Mulhim, 2021). However, the use of infographics in the teaching and learning of Chemistry in the secondary schools in Akwa Ibom State has not attracted much attention as Chemistry classrooms activities are stiill dominated by teacher-centred methods without the use of adequate instructional materials. Hence, the need for a paradigm shift from a teacher-centred learning environment to a student-centered learning environment through the use of infographic instructional materials. This has therefore made it necessary to investigate the effectiveness of animated and static infographic instructional materials on students' academic performance in isomerism in organic chemistry.

Animated infographic instructional material is a visual representation of concepts, data and information using a combination of imagery, illustrations, charts, graphs, text, and other elements that are animated to add movement (Hennequin, 2019; Etim, Itighise & Ema, 2016). Infographics can make complex ideas more engaging, easier to understand and enhance retention rates. The combination of movement, visuals and information creates a dynamic experience that encourages viewers to stay focused on content in a structured, compelling manner. These materials are considered interactive because they invite user input, allowing for the collection of statistics, data, and other information (Shaltout & Fatani, 2017).

An animated infographic on isomerism is an interactive visual material designed to enhance students' understanding by dynamically illustrating how molecules with the same molecular formula can exist in different forms. This instructional material illustrates structural isomerism (including chain, position, functional group, and metamerism) and stereoisomerism (covering geometrical (cis-trans) and optical isomerism). Through motion graphics, the animation shows real-time transformations, such as the shifting of functional groups in position isomerism (e.g., 1-propanol vs. 2-propanol) or the conversion between keto and enol forms in tautomerism. In geometrical isomerism, the animation highlights restricted rotation around a double bond, comparing cis-2-butene and trans-2-butene, while in optical isomerism, it illustrates the mirror-image relationship of L- and D-lactic acid. By incorporating 3D molecular rotations, labeled diagrams, and stepwise transformations, the animated infographic helps students visualize molecular rearrangements, grasp key differences, and connect theoretical concepts to real-world applications, ultimately improving their comprehension and retention of isomerism in Chemistry (Boco, Miralles & Malindog, 2020; Al-Behadili & Al-Dayni, 2022).

A static infographic instructional materials is stationary visual representation of information, data or concepts designed to communicate complex ideas in a simple, engaging and easily comprehensible format. Static infographics rely on clear diagrams, charts, text and color coding to communicate information withuot movement (Locoro, Cabitza, Actis-Grosso, & Batini, 2017). Typically, static infographics serve as fixed resources that do not require user interaction (Shaltout & Fatani, 2017). Images that use visual elements like charts, diagrams, and text to convey information graphic that remains unchanged over time. Static infographics are relatively quick and cost-effective to produce, making them accessible for use in a variety of contexts.

A static infographic on isomerism is a visually structured instructional material designed to enhance students' comprehension by presenting key concepts through clear diagrams, labeled molecular structures, and concise explanations. This infographic categorizes isomerism into structural isomerism (including chain, position, functional group, metamerism, and tautomerism) and stereoisomerism (covering geometrical (cis-trans) and optical isomerism). Each type illustrated a color-coded molecular structures, showing variations in atomic connectivity or spatial arrangement. For example, chain isomerism illusted with butane and isobutane, to demonstrate differences in carbon chain branching, while position isomerism compared 1-propanol and 2-propanol, highlighting shifts in functional group location. In geometrical isomerism, the infographic contrast cis- and trans-2-butene, illustrating the restricted rotation around a double bond. For optical isomerism, L- and D-lactic acid showcased a non-superimposable mirror images. The static infographic provided a structured, easy-to-read format, allowing students to analyze molecular differences at a glance, improving retention and engagement in learning isomerism in Chemistry (Boco, Miralles & Malindog, 2020; Al-Behadili & Al-Dayni, 2022).

Researchers have reported the effectiveness of using infographics to enhance students' understanding of complex chemical concepts. Boco et al. (2020) investigated the effectiveness of both animated and static infographics in teaching chemical bonding, reporting that properly designed infographics can significantly improve students' comprehension of intricate subjects. Similarly, Al-Behadili and Al-Dayni (2022) found that incorporating infographics into chemistry instruction positively impacted students' acquisition of chemical concepts. These findings suggest that integrating infographic instructional materials into the teaching and learning of the concept of isomerism could enhance students' grasp of the topic by providing clear, visual representations of different isomer types and their structures.

Gender is one of the factors that may influence students' academic performance in Chemistry. Some studies report that gender disparities exist in students' academic achievement in science and others have found no significant difference when effective and innovative teaching methods and materials are employed (Umanah, 2024; Umanah & Akpan, 2024; Lasisi et al., 2021, Umanah & Udo, 2015). However, effective teaching methods and materials should improve academic performance for both male and female students. This study therefore sought to determine whether animated and static infographic instructional materials would be effective in improving students' academic performance in isomerism in organic Chemistry equally for both male and female students.

Statement of the Problem

The persistent underachievement in Chemistry among secondary school students, as evidenced in the West African Senior School Certificate Examination (WASSCE), underscores the need for the use of more effective and engaging teaching methods and instructional materials. The study of isomerism in organic chemistry poses a serious challenge to students due to its abstract nature and requires students to visualize molecular structures, identify spatial arrangements and understand how different forms of the same molecular formula exhibit distinct physical and chemixal properties. However, traditional teaching methods often dominated by textbook explanations and chalkboard illustrations fail to effectively engage students, leading to misconceptions, poor comprehension, low retention and poor academic performance. To address these challenges, visual instructional materials, such as animated and static infographic instructional materials have emerged as potential solutions for simplifying complex concepts, enhancing student engagement and improving students' understanding of complex scientific concepts. Researchers have reported that incorporating infographics into teaching can significantly improve students' academic performance. However, there remain a gap in empirical evidence comparing the effectiveness of animated and static infographic instructional materials on students' academic performance in the concept of isomerism in organic chemistry. This study, therefore, sought to investigate the effect of animated and static infographic instructional materials on students' academic performance in isomerism in organic chemistry in Mkpat Enin Local Government Area, Akwa Ibom State, Nigeria.

Purpose of the Study

This study investigated the effect of animated and static infographic instructional materials on students' academic performance in isomerism in organic chemistry. Specifically, the study sought to:

1. determine the difference in the mean performance scores of Chemistry students taught the concept of isomerism using animated and static infographic instructional materials.
2. ascertain the difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Research Questions

The following research questions were raised to guide the study:

1. What is the difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials?
2. What is the difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials?

Hypotheses

The following hypotheses were formulated and tested at a 0.05 level of significane.

1. There is no significant difference in the mean performance scores of Chemistry students when taught the

INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue IIIS March 2025 | Special Issue on Education

concept of isomerism using animated and static infographic instructional materials.

2. There is no significant difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

METHODOLOGY

This study adopted a quasi-experimental non-randomized pre-test, post-test design.

The study was conducted in Mkpat Enin Local Government Area, Akwa Ibom State, Nigeria. The population of the study consisted of all the 1846 SS2 Chemistry students in the 16 public co-educational secondary schools in the 2023/2024 academic session in Mkpat Enin Local Government Area, Akwa Ibom State. The sample size comprised 87 SS2 Chemistry students in two intact classes from the two secondary schools in the study area selected using a simple random sampling technique. In each of the selected schools, one intact class of SS2 Chemistry students was randomly assigned to Experimental Group 1 (taught using animated infographics) and Experimental Group 2 (taught using static infographics) respectively. One instrucment was used in gathering data for the study, viz: a 50- item 4-option multiple choice test with four options (A-D) tagged: Chemistry Performance Test on Isomerism (CPTI), designed to measure the pret-test and post-test performance in the concept of isomerism in Chemistry. To ensure its face and content validity, the instrument was submitted to three independent assessors; two Chemistry education lecturers and one expert in Test, Measurement and Evaluation all in the Department of Science Education, Akwa Ibom State University. The reliability index of the Performance Test on Isomerism was determined using the Kuder Richardson Formula-20 and a reliability coefficient of 0.85 was obtained. In scoring the test instrument (CPTI), each correct answer was scored 2 marks while an incorrect answer was scored zero. The total mark earned was 100 marks while the minimum mark was zero. After selecting the sample schools and assigning them to the two trearment groups, the Performance Test on Isomerism (CPTI) was administered to the SS2 Chemistry students in the two treatment groups as pretest. The pre-test was to serve as a covariate to control for the initial differences among the students. Thereafter, treatment was given to the groups on the concept of isomerism for two weeks. The students in treatment Group 1 were taught using the animated infographic instructional material while those in treatment group 2 were taught using the static infographic instructional materials. At the end of the treatment session, the Performance Test on Isomersim (CPTI) was administered to the students in the two treatment groups as a post-test. The data generated from the pre-test and post-test were analysed using mean, standard deviation and Analysis of Covariance (ANCOVA) statistics. Mean scores were used for answering the two research questions, while ANCOVA was used in testing the two hypotheses formulated. All the hypotheses were tested at a 0.05 level of significance.

RESULTS

Research Question One

What is the difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials?

Table 1: Mean and standard deviation of the difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographics instructional materials

Instructional materials	N	Pretest		Posttest		Mean difference	Mean gain
		Mean	SD	Mean	SD		
Animated	43	4.61	1.85	14.65	2.98	10.04	2.00
Static	44	4.46	2.15	12.50	2.47	8.04	

The result in Table 1 indicated that the pretest–posttest mean scores difference of 10.04 obtained by students

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue IIIS March 2025 | Special Issue on Education

taught the concept of isomerism using animated infographic instructional materials was greater than that of 8.04 obtained by those taught using the static infographic instructional materials with a mean gain of 2.00. The standard deviation scores for the pretest and posttest were 1.85 and 2.98 for those taught using animated infographics, 2.15 and 2.47 for those taught using static infographics. This implies that although students taught with the animated infographics had a higher mean score difference, the variability in their scores was slightly greater. This means that there is difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials in favour of those taught using the animated infographic instructional materials.

Research Question Two

What is the difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials?

Table 2: Mean and standard deviation of difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Instructional materials	**Gender**	**N**	**Pretest**		**Posttest**		**Mean difference**	**Mean gain**
			Mean	**SD**	**Mean**	**SD**		
Animated	Male	21	4.33	1.68	14.33	2.99	10.00	0.10
	Female	22	4.86	2.01	14.96	3.00	10.10	
Static	Male	21	3.52	1.89	11.62	2.04	8.10	0.10
	Female	23	5.30	2.06	13.30	2.60	8.00	

The result in Table 2 showed that the pretest–posttest mean gain difference for male and female students taught the concept of isomerism using animated infographic instructional material was 0.10 while the pretest–posttest mean gain difference for male and female students taught the concept of isomerism using static infographic instructional material was 0.10. This means that there is no difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials. The post-test standard deviation scores displayed showed that, though the female students in the animated infographics group had the highest post-test score, the variability in their scores was also slightly greater.

Hypothesis One

There is no significant difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Table 3: Result of ANCOVA analysis of the difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	195.12[a]	2	97.56	15.17	.00
Intercept	1759.48	1	1759.48	273.55	.00

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue IIIS March 2025 | Special Issue on Education

Pretest	94.48	1	94.48	14.69	.00
Instructional_materials	93.27	1	93.27	14.50	.00
Error	540.29	84	6.43		
Total	16740.00	87			
Corrected Total	735.40	86			

The result in Table 3 showed the F-ratio of 14.50 and the corresponding probability level of significance of .00 alpha at 1 and 84 degrees of freedom. This level of significance is less than .05 on which the decision is based. With this result, the null hypothesis was rejected. This implies that there is a significant difference in the mean performance scores of Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Hypothesis Two

There is no significant difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Table 4: Result of ANCOVA analysis of the difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	203.48[a]	4	50.87	7.84	.00
Intercept	1675.85	1	1675.85	258.35	.00
Pretest	67.52	1	67.52	10.41	.00
Instructional_materials	95.14	1	95.14	14.67	.00
Gender	7.38	1	7.38	1.14	.29
Instructional_materials* Gender	1.20	1	1.20	.19	.67
Error	531.92	82	6.49		
Total	16740.00	87			
Corrected Total	735.40	86			

The result in Table 4 showed the F-ratio of .19 and the corresponding probability level of significance of .67 alpha at 1 and 82 degrees of freedom. This level of significance is greater than .05 on which the decision is based. With this result, the null hypothesis was retained. This implies that there is no significant difference in the mean performance scores of male and female Chemistry students when taught the concept of isomerism using animated and static infographic instructional materials.

DISCUSSION OF FINDINGS

The analysis of the difference in the mean performance scores of Chemistry students, when taught the concept of isomerism using animated and static infographic instructional materials, showed a significant difference in the mean performance scores of Chemistry students. The finding can be attributed to the fact that animated infographics provide a dynamic step-by-step visualization, reduces misconceptions, helping the students to better understand complex molecular structures, rotations and transformations in isomerism. Unlike static infographics, which present fixed images, animations demonstrate the movement of atom and bonds, making the concept of isomerism more concrete and easier to understand. The finding lends credence to that of Boco, Miralles, and Malindog, (2020) whose finding showed that students exposed to animated infographic instructional material obtained higher post-test mean scores compared to those who were exposed to static infographic instructional materials.

The analysis of the difference in the mean performance scores of male and female Chemistry students, when taught the concept of isomerism using animated and static infographic instructional materials, showed no significant difference in the mean performance scores of male and female Chemistry students. This finding is because both animated and static infographic instructional materials were gender-friendly as these materials affected students' learning equally ensuring that both male and female students academic performance were improved. The finding contradicts that of Ibrahem and Alamro (2021) who found that the use of static infographics had a greater effect on female students learning while animated infographic was found more effective for male students learning.

CONCLUSION

Based on the findings of this study, it was concluded that animated infographic instructional materials significantly enhanced students' academic performance in isomerism in organic chemistry compared to those taught using static infographic instructional materials. This implies that animated infographics enhanced comprehension of the concept of isomerism more effectively than visual infographic intructional materials. Additionally, thes also showed no significant difference in the mean performance scores between male and female students when taught using both instructional materials, implying that animated and static infographics enhanced both male and female students' academic performance equally.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Chemistry teachers should incorporate animated infographic instructional materials into teaching isomerism and other complex organic chemistry concepts to enhance students' conceptual understanding and academic performance.

2. Professional development programs should be organized to train Chemistry teachers on the effective use of animated infographics in teaching Chemistry.

3. Educational developers should integrate animated infographic materials into the Chemistry curriculum to promote interactive and engaging learning experiences.

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