EFFECT OF ANALOGY AND METAPHOR-ORIENTED PEDAGOGICAL METHODS ON THE ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL STUDENTS IN GENETICS IN ILORIN, NIGERIA

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ABSTRACT

This research explored the impact of analogies and metaphors on the academic performance of senior school students in genetics within Ilorin, Nigeria. Three research questions and corresponding hypotheses were formulated and tested at a significance level of .05. A quasi-experimental design was used, involving 117 senior secondary school students. Data collection was facilitated through the Genetic Achievement Test (GAT), and the results were analyzed utilizing t-tests and analysis of covariance. The study's results indicated a significant difference in student performance, with those taught through analogy outperforming those exposed to metaphor-based teaching methods. No notable difference was found between male and female students using either instructional approach. It was concluded that both strategies can effectively foster conceptual understanding and improve student outcomes. Consequently, it is recommended that educators implement both techniques in teaching genetics and other challenging biological topics.

Keywords: *Analogy, Metaphor, Gender, Achievement*

INTRODUCTION

Effective communication is vital in every community, including educational environments, as it ensures the accurate transmission of information without misunderstandings. Classroom interactions between teachers and learners are crucial in fostering meaningful learning experiences. For communication to be effective, especially in a typical classroom setting, teachers and students must use a mutually understood language. According to Abimbola (2015), communication is central to formal and informal learning processes, serving as a medium for expressing thoughts, beliefs, intentions, and emotions.

The significance of instructional language in facilitating meaningful learning is crucial in science education, where terminology and specialized vocabulary often differ from everyday language. Larsson (2011) emphasized that the complexity and abundance of words in science can pose significant challenges, particularly for students learning science through a second language.

Various authors and researchers have defined science differently, concentrating on its products, procedures, or techniques (Abimbola, 2017). Abimbola (2013) opined that science can be conceptualized as an aggregation of empirical knowledge, a systematic approach to inquiry that yields theoretical elucidations for observable phenomena, or a mechanism for enhancing our comprehension of the natural environment. Science is also viewed as a structured body of knowledge that depends on empirical observation and methodical experimentation concerning the empirical universe. (Science, 2010). Essentially, the discipline of science constitutes an endeavour to acquire knowledge via meticulous scrutiny of phenomena occurring in the natural world.

Biology is a discipline within the life sciences that focuses on studying living organisms (Lumencadela, 2016). Its teaching is crucial as it imparts skills necessary for societal development and enables learners to better understand the world around them. Biology is essential for pursuing medical and life science programs at the tertiary level in Nigeria. Moreover, it covers a wide range of topics related to life sustainability, such as ecosystems, environmental issues, disease causes, serum development, and global challenges encompassing waste management, starvation, ecological ruin, and community well-being.

Biology and its associated fields are well regarded at every tier within the context of the Nigerian educational framework (Owoeye, 2016), with a significant number of students opting for biology than other scientific subjects, particularly at the secondary educational level (Ahmed & Abimbola, 2011). The allure of biology may be attributed to its distinct characteristics that differentiate it from other scientific fields. Mayr (2004) characterized biology as a genuine science encompassing functional and historical dimensions. In contrast to other scientific disciplines, biology is not limited by universal principles, essentialism, determinism, or reductionism. Adegboye et al. (2017) further contended that although the fundamental laws of the physical sciences are applicable to functional biology, they do not extend their reach to historical biology. Instead, distinct principles that regulate living organisms assume greater importance.

Although biology is a critical subject for human advancement, student performance in Nigeria has, for the most part, exhibited a level of performance that is considered inadequate. This inadequacy is with the exception of the preceding eight years, during which there has been a sustained increase in the success rates for the West African Senior School Certificate Examinations (WASSCE) as delineated in Table 1. Notwithstanding the fact that biology is conventionally confined to students pursuing the sciences, it has perpetually exhibited the highest number of candidates compared to other scientific disciplines, e.g., Physics and Chemistry, as illustrated in Table 1. The pass rates for biology have steadily improved from 51.73% in 2013 to 74.40% in 2019. Despite this, there is still room for improvement, as the goal of teaching and learning is to ensure thorough understanding.

Table 1. *Analysis of student enrollment trends and academic outcomes in the disciplines of biology, chemistry and physics during the May/June Senior School Certificate Examinations from 2010 to 2019*

Year	Biology			Chemistry			Physics		
	Overall Enrolment	Pass Grade (A1-C6)	% Pass	Overall Enrolment	Pass Grade (A1-C6)	% Pass	Overall Enrolment	Pass Grade (A1-C6)	% Pass
2010	1,300,418	427,644	32.88	465,643	263,059	50.70	463,755	237,756	51.27
2011	1,505,199	479,432	38.50	565,692	280,280	49.54	563,161	360,096	63.94
2012	1,646,150	587,044	35.66	627,302	270,570	43.13	624,658	429,415	68.74
2013	1,648,363	852,717	51.73	639,296	462,517	72.34	637,023	297,988	46.77
2014	1,365,384	766,971	56.17	636,268	397,649	62.49	635,729	386,270	60.76
2015	1,390,234	798,246	57.42	680,357	412,323	60.60	684,124	410,543	60.01
2016	1,200,367	740,345	61.68	706,873	408,122	57.74	705,125	415,655	58.95
2017	580,499	394,898	68.03	377,970	320,635	84.83	377,851	205,757	54.45
2018	1,087,063	679,299	62.49	728,551	424,231	58.23	728,354	571,687	78.49
2019	1,033,305	775,103	75.01	726,132	566,156	77.97	725,853	565,746	77.94

Source: West African Examinations Council, Lagos, Nigeria

Several additional variables identified as contributing to the difficulties students encounter in grasping biological concepts include the inherent properties of the subject matter, instructional methodologies utilized by educators, and the abstract nature of certain concepts (Cimer, 2012). Moreover, the terminology frequently presents challenges as it is often unfamiliar or confusing, primarily stemming from Greek and Latin roots; for example, lexemes such as *Zygo* (to join), *Phago* (to consume), *Olig* (few) and *Locus* (place) (Wellington & Osborne, 2001). The spectrum of abstract and foundational biological concepts encompasses subjects such as the mechanism of water transport in plants, the process of respiration, principles of Mendelian genetics, the operational dynamics of the central nervous system, the structure and function of genes and chromosomes, along with the processes of mitosis and meiosis, as well as themes of evolution, ecology, reproduction, and the structural and functional characteristics of enzymes (Chima & Onyebuchi, 2011; Cimer, 2012). Several of these topics are intricately associated with genetic phenomena (Yu-Chien, 2008).

Within the secondary education Biology curriculum, genetics is pivotal in fostering innovations that significantly impact human existence. Genetics, as a distinct branch of biology, is concerned with investigating inheritance and variation (Ramalingam, 2011). This discipline studies the mechanisms through which genes are transmitted across generations or the conveyance of biological characteristics from progenitors to their descendants mediated by genetic activity (Ambuno et al., 2008; Alabi, 2016).

According to the West African Examinations Council (WAEC) Chief Examiners' Reports (2009, 2010, 2012, 2013, and 2015), many biology students avoided answering questions related to genetics, and those who did often performed poorly. In 2010, 2012, and 2016, students exhibited an inadequate understanding of genetic crossing and sex determination, with many incorrectly using "M" for male and "F" for female rather than the correct "XX" and "XY" chromosome pairs. Furthermore, WAEC reports from 2015, 2017, and 2018 showed that candidates frequently skipped genetics-related questions and neglected to use "X" as the symbol for gamete crossing. These challenges highlight the need to reassess how biology, particularly genetics, is taught.

Biology curriculum is most often voluminous. Teachers frequently use a teacher-centered teaching approach, e.g., the lecture method, to cover all the topics scheduled for coverage before students sit for external examinations such as the West African Examination Councils exam. The predominant pedagogical approach utilized by classroom educators involves the use of traditional lecture methodologies rather than the implementation of innovative instructional strategies, attributing this reliance to the constraints imposed by the educational environment and the extensive nature of the curricula (Mehmood & Zahoor-ur-Rehman, 2011). Most teachers often adopt the conventional method of teaching because this method has been found to allow teachers to cover a wider area within a short time (Sam et al., 2018). The use of the conventional method often reduces students' engagement and participation as the teachers assume total control of class activities (Wang, 2022). Consequently, it is imperative to rigorously evaluate the methodologies through which genetics can be imparted to students, aimed at facilitating profound learning experiences. Among the diverse spectrum of novel educational methodologies applied in instructional practices are demonstration kits, analogies, metaphors, concept mapping, the jigsaw technique, strategically applied classroom technology, project-based learning, quick response codes and inquiry-based learning (Davis, 2017). Science educators regularly utilize analogies and metaphors in their instructional practices, particularly when addressing inquiries by utilizing well-known environmental components or constructs to clarify novel concepts. This research aims to purposefully incorporate instructional methodologies that employ analogy and metaphor, followed by an evaluation of their impact on the pedagogy of genetics for senior secondary school learners.

Analogy and metaphor represent forms of instructional techniques grounded in comparative frameworks, as both strategies facilitate learners in leveraging their pre-existing knowledge by correlating previously acquired information with abstract concepts that are yet to be understood. As elucidated by Aubusson et al. (2006), analogy involves delineating the distinctions between two concepts by utilizing the familiar to elucidate the unfamiliar. Conversely, Rani Kanthan and Mills (2011) characterize metaphor as a mode of expression wherein a term or phrase typically signifying one entity is employed to imply another, thereby creating an implicit comparison. The distinction between metaphor and analogy in the context of science education lies in the premise that metaphor posits A as B, while analogy posits A as similar to B. Metaphors are linked to pedagogical perspectives, whereas analogies are predominantly associated with the elucidation of scientific content; ultimately, metaphors tend to be covert, in contrast to the overt nature of analogies (Aubusson et al., 2006).

Table 2. *Distinction existing between the concepts: Analogy and metaphor*

	Analogies	**Metaphors**
1	Represents a precise simile	Denotes an implied simile
2	They posses a high degree of accuracy	They are fundamentally inaccurate
3	Analogies are easily discernible	Requires additional cognitive efforts for interpretation
4	An analogy maintains logical coherence	A metaphor upholds emotional resonance
5	Analogies are explicit in nature	Metaphors are implicit
6	Derives from the Greek term *analogia*, signifying proportion	Originates from the Greek term *Metaphora*, which conveys the idea of transfer

Source: Aubusson et al. (2006); Guerra-Ramos (2011); stackexchange.com (2018).

The employment of analogies and metaphors as pedagogical methodologies is informed by the social constructivism framework articulated by Lev Vygotsky, who posited that a child's capacity for learning can be facilitated and mediated through their participation in social exchanges with their more knowledgeable peers or educators. The theory emphasizes the significant role played by language and culture in which all learning tasks can be carried out under the supervision of a more knowledgeable individual or peer collaboration (Akpan et al., 2020). Social constructivism is appropriate for the studies because it involves teachers assumed to be more knowledgeable in utilizing analogies and metaphors which are linguistic tools to explain abstract concepts in genetics. Aside from the role of the teacher, the students were also allowed to generate their analogies and metaphors to comprehend genetic concepts better.

Numerous scholars have employed analogy and metaphor as pedagogical strategies for instructional purposes to determine whether a statistically significant difference would exist in the achievement of students who were exposed to either of the instructional strategies when compared with the conventional teaching method. For instance, Tispi (2016) examined the hemispheric processing associated with two distinct categories of metaphors concerning high school students' performance in genetics. The research was quasi-experimental, with the sample comprising 12th-grade students enrolled in biology courses. The findings from this study indicated that pupils exposed to metaphors structured as "A is B" exhibited a more rapid processing of information compared to those engaged with the simile "A is like B" within the left hemisphere. It was therefore concluded that teachers should resort to using language that promotes comparison rather than categorization when they intend to use metaphors to teach new concepts. This present study however categorizes the use of the linguistic structure A is similar to B as an analogy, and the linguistic structure A is B as a metaphor.

In a separate investigation, Awofodu (2016) similarly analyzed the disparity in the academic performance of students instructed in ecology through the metaphor instructional approach instead of the traditional teaching method. The results indicated a notable distinction in the academic performance of students who were subjected to metaphor instruction compared to those who received instruction via the conventional teaching method, with the findings favoring the metaphor group.

Likewise, a study that investigated the influence of analogy-based instructional strategies on students' academic performance when engaging with DNA concepts was carried out by Ameyaw and Kyere (2018). The research methodology employed in this inquiry was a quasi-experimental design characterized by the non-random assignment of participants. A sample comprising 39 students, consisting of seventeen males and twenty-two females, was utilized for the study. The Molecular Concept Achievement Test (MCAT) is the tool for gathering crucial data. Initially, all 39 participants were instructed on the DNA concept without incorporating any analogy-based pedagogical techniques, concluding with an assessment using the MCAT to obtain baseline test scores. This same group of learners engaged with analogy-based instructional techniques for two additional weeks. The results indicated a statistically significant difference in students' performance regarding DNA concepts, as the analogy-based instructional strategy markedly enhanced student outcomes compared to traditional lecture-based instruction, exemplified by a mean difference of 10.51. The current study, however, aims to provide a comprehensive approach to teaching genetics by utilizing analogies and metaphors rather than concentrating solely on a singular facet of genetics.

Chinaka (2021) also examined the effectiveness of the "Dance with Fruits" analogy in mitigating student misconceptions related to acids and bases. The research adopted a mixed-methods design, with participants selected from a cohort of grade 11 physical science students. Data collection was facilitated through the Acid and Base Alternative Conception Test, and the analysis revealed that students who were instructed using analogies demonstrated a reduced prevalence of alternative conceptions compared to their peers within the control group. Consequently, it was suggested that science educators incorporate analogical reasoning to enhance student comprehension of abstract scientific concepts.

In addition to the pedagogical approaches utilized, variables such as students' gender, academic standing and cognitive styles significantly influence the comprehension of abstract scientific concepts. Investigative efforts into the effects of gender on academic performance have produced inconclusive findings. While particular studies have identified significant differences in achievement attributable to gender, others have found no significant correlation between gender and academic success. For example, Okoronka and Wada (2014) posited that there were no significant disparities in the achievements of male and female students when taught specific physics concepts utilizing an analogy instructional strategy. A significant number of academic inquiries have converged on the conclusion that gender does not markedly influence the educational success of students (Aderogba, 2006; Pinar & Tekkaya, 2008). In contrast, alternative studies have posited that gender plays a considerable role in the academic performance of male students relative to their female peers within the fields of Science, Technology, and Mathematics (STM) (Adebayo, 2002) or that female students may surpass their male counterparts academically (Danmole, 1998).

Nomsoor et al. (2021) investigated the gallery walk instructional strategy's ramifications on students' performance in cell division. The methodological framework of the research was conducted using a quasi-experimental design, and the sample consisted of 79 senior school students selected through a simple random sampling technique. Gender was incorporated as a moderating variable, and the analysis on gender indicated that there was no statistically significant difference in the academic performance of male and female students who engaged with cell division through the gallery walk instructional strategy. In light of these findings, it was proposed that the Gallery Walk Instructional Strategy (GWIS) be utilized in the context of a mixed-gender classroom, as it would facilitate both genders in the process of knowledge construction.

The effects of the concept-mapping pedagogical strategy on students' academic outcomes in biology were examined by Ahmed et al. (2021). The investigators employed a quasi-experimental research design. The subject population consisted of all students offering biology, from which a sample of 149 individuals was drawn from two complete cohorts. Two distinct research instruments were utilized in the investigation, and the data collected were analyzed using ANCOVA. Findings indicated statistically significant differences in the achievements of male and female students who were exposed to the concept-mapping instructional method. Consequently, it was concluded that students' academic performance in scientific disciplines was not influenced.

The effects of gender and mentoring on the academic performance of low-achieving Biology students were studied by Jegede and Olu-Ajayi (2017). The researchers employed a quasi-experimental design that included 180 senior secondary students from six secondary educational institutions. Data were collected using the Biology Concept Test. The results demonstrated a significant disparity in the academic achievement scores of students who were exposed to the Classroom Adjunct Instruction Learning Model (CAILM), with the results favoring female students. Therefore, it was recommended that educators adopt mentoring as a supplementary approach to conventional classroom instruction to enhance students' academic performance in Biology.

Nawaf (2016) conducted a study to assess how well Jordanian students comprehended organic chemistry principles through analogy as an instructional approach. A sample of ninety-seven students participating in an organic chemistry course was utilized in this quasi-experimental study. ANCOVA and independent t-tests were used to analyze the Chemical Concept Achievement Test data. The study's findings revealed that instruction provided through the analogy method was nearly equally advantageous for both male and female students. Consequently, the literature review indicates a persistent lack of consensus among scholars regarding the impact of gender on students' academic performance in the sciences. This discovery underscores the importance of including gender as a variable of research interest.

Research Questions

1. Do metaphors and analogies affect senior secondary school students' academic performance in genetics in Ilorin, Nigeria?
2. Does the academic performance of students who were taught genetics using an analogy-based teaching technique differ noticeably based on gender?
3. How do male and female senior school students who are taught genetics utilizing the metaphor instructional technique differ in their academic performance?

Research Hypotheses

H_{01}: There exist no statistically significant effects attributable to analogy and metaphor instructional strategies on the academic achievement of senior school students in the subject of genetics.

H_{02}: There exists no statistically significant disparity in the achievement of male and female students instructed in genetics utilizing the method of analogies.

H_{03}: There exists no statistically significant disparity in the achievement of male and female students instructed in genetics employing the method of metaphors.

METHODOLOGY

Research Design

The research design employed in this study adopts a quasi-experimental, non-randomized framework that comprises a pre-test, post-test, and a control group, characterized by a 3 x 2 factorial design. The initial three aspects of the factorial design represent the three pedagogical strategies utilized in this investigation: analogy, metaphor, and conventional teaching methods; conversely, the subsequent two elements delineate the gender of the participants, which is categorized into two distinct levels: male and female. The dependent variable examined in this study was the biology students' pre- and post-test scores on the Genetics Achievement Test. The study's independent variables comprised the instructional strategies (traditional, analogy, and metaphor), with gender functioning as a moderating variable.

Participants

All senior school students in Ilorin, Nigeria studying biology made up the research population, and all students in their third year of secondary school (SSS III) also studying biology in Ilorin made up the focus population. The sample utilized for this investigation encompassed 117 senior high school students, 64 male and 53 female.

Two co-educational senior secondary schools in Ilorin were chosen using purposive sampling. The schools were purposefully chosen based on the following criteria: they must not be close to one another, have a biology teacher teaching SS III, and have a class size of at least 30 pupils. However, a simple random sample procedure was utilized to assign the purposefully selected secondary schools into Experimental Groups 1 and 2. Students taught using analogy teaching strategy were assigned to Experimental Group 1, while the students taught genetics using metaphor instructional strategies were assigned to Experimental Group 2.

Data Collection Tool
Two primary instruments were employed in the data collection process, specifically, those utilized for stimulus and response. The previously mentioned stimulus instruments included the Educators' Instructional Manual on Analogies and the Educators' Instructional Manual on Metaphorical Instructions. These stimulus instruments were employed by educators in genetic concepts teaching. These stimulus instruments were also implemented by educators in genetic concepts instruction. The response instrument utilized was the Genetic Achievement Test (GAT), which encompassed 53 multiple-choice items, each offering four possible responses labeled A-D. The GAT functioned as a test instrument designed by the researcher to assess students' proficiency regarding the concepts introduced during the study. Furthermore, the GAT underwent item analysis to ascertain item relevance through calculating difficulty and discrimination indices. The evaluation of these indices was conducted using the responses from students who were not part of the sample population involved in the principal research. The findings from the item analysis resulted in the exclusion of three items and the revision of two additional items.

Students and educators involved in the study received copies of informed consent documents that elucidated the research objectives. The ethical considerations governing the utilization of human subjects in the research were explicitly articulated and adhered to throughout the study. The experimental phase was four weeks within each of the selected educational institutions. The initial week was allocated for administrating the pre-test, and the data derived from this assessment were utilized as covariates during the subsequent data analysis. The second and third weeks were dedicated to the simultaneous instruction of the various groups participating in the study. In alignment with ethical considerations, students from the first and second groups, following their random assignment into experimental groups one and two, received instruction in genetics utilizing analogy and metaphor teaching strategies at the designated times outlined in the school's Biology lesson timetable. Concurrently, students in the control group were also instructed during the same period, as this timeframe corresponded with the scheduled teaching of the topic within the academic scheme. Instructing outside of the allocated time would disrupt students' preparation for examinations and would contravene ethical standards. The fourth week was reserved to administer the post-test to all participating groups.

Data Analysis Technique
Data collected were subjected to an analytical process utilizing descriptive statistical measures, specifically the mean and standard deviation, to address the research questions. Concurrently, the *t-Test* and Analysis of Covariance (ANCOVA) were employed for the examination of the research hypothesis at a significance level of 0.05. Research hypothesis I was evaluated applying ANCOVA, whereas hypotheses II and III were assessed utilizing the *t-Test* statistical methodology.

FINDINGS

H01: There exist no statistically significant effects attributable to analogy and metaphor instructional strategies on the academic performance of senior school students in the subject of genetics.

The ANCOVA results presented in Table 3a indicated that an F-value of 13.511 was calculated alongside a p-value of 0.000 at the 0.05 alpha level. Given that the p-value of 0.000 is inferior to the 0.050 alpha threshold, the null hypothesis I was consequently rejected. Thus, it was determined that there are statistically significant effects of analogy and metaphor instructional strategies on the academic performance of senior school students in genetics ($F_{(1,114)}$= 13.511, p<.05).

Table 3a. *Analysis of Covariance illustrating the impacts of analogy and metaphor instructional strategies on the academic performance of senior school students in genetics*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	22203.595[a]	3	7401.198	138.124	.000
Intercept	5545.463	1	5545.463	103.491	.000
Pretest	12888.291	1	12888.291	240.525	.000
Group	1447.980	2	723.990	13.511	.000
Error	9109.261	170	53.584		
Total	449577.000	174			
Corrected Total	31312.856	173			

a. R Squared = .709 (Adjusted R Squared = .704)

The Multiple Comparison Analysis is delineated in Table 3b to elucidate which instructional strategy yielded the most pronounced effect on the academic performance of senior school students in genetics. As evidenced in Table 3b, the Analogy instructional strategy exerted a greater influence on students' academic performance (mean score of 52.905) in genetics, followed by the Metaphor instructional strategies with a mean score of 49.285, while students subjected to conventional strategies exhibited the lowest achievement score (45.011).

Table 3. *Bonferroni Post Hoc Pairwise Comparisons of the effects of analogy and metaphor instructional strategies on the academic performance of senior school students in genetics*

(I) Group	Mean	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Analogy Group	52.905[a]	Metaphor Group	3.620*	1.445	.040	.125	7.115
		Conventional	7.894*	1.531	.000	4.193	11.595
Metaphor Group	49.285[a]	Analogy Group	-3.620*	1.445	.040	-7.115	-.125
		Conventional	4.274*	1.352	.006	1.005	7.543
Conventional	45.011[a]	Analogy Group	-7.894*	1.531	.000	-11.595	-4.193
		Metaphor Group	-4.274*	1.352	.006	-7.543	-1.005
Grand Mean	***49.067***						

Based on estimated marginal means

**. The mean difference is significant at the .05 level.*

b. Adjustment for multiple comparisons: Bonferroni.

HO_2: There exists no statistically significant disparity in the academic performance of male and female students instructed in genetics utilizing the method of analogies.

The independent sample t-Test was utilized to evaluate the hypothesis, as delineated in Table 4. Table 4 discloses that a t-value of 0.65 was computed at a degree of freedom (1, 53), resulting in a p-value of 0.52. Given that the p-value exceeds the alpha threshold of 0.05, the hypothesis was not rejected. Consequently, it was determined that there was no significant difference in the academic accomplishments of male and female students taught genetics through analogy, at t-value t(53)=.65, p =.52.

Table 4. *Independent Sample t-Test of Students Exposed to Analogies Based on Gender*

Treatment	Gender	N	*M*	SD	*df*	*T*	Sig.	Remark
Analogy	Male Female	28 27	51.18 46.74	18.96 13.20	53	.65	.52	NS

HO₃: There exists no statistically significant disparity in the academic performance of male and female students instructed in genetics employing the method of metaphors.

The independent sample t-Test was utilized to assess hypothesis III, as presented in Table 5. Table 5 indicates a t-value of 0.40 at a degree of freedom (1, 60), which resulted in a p-value of 0.69. The calculated t-value t(60)=.40, p =.69 was not significant, as the p-value surpassed 0.05. Therefore, the null hypothesis, which posits that there is no statistically significant difference in the academic performance of male and female students instructed in genetics through the use of metaphor, was not rejected.

Table 5. *Independent Sample t-test of Students Exposed to Metaphor Based on Gender*

Treatment	Gender	N	*M*	SD	*df*	*t*	Sig.	Remark
Metaphor	Male Female	35 27	47.09 48.30	7.92 8.01	60	.40	.69	NS

DISCUSSION

The findings derived from the research indicated that students exposed to analogy and metaphor instructional methodologies demonstrated a significantly enhanced performance in genetics; however, those who were instructed utilizing analogy exhibited superior outcomes compared to their peers who received instruction via metaphorical strategies. The educational implications of this discovery suggest that both instructional methodologies can foster a conceptual transformation among learners and concurrently enhance their academic performance. The observed disparity in achievement between students exposed to analogy and metaphor instruction, favoring the analogy group, may be attributable to the inherent capacity of both strategies to enable learners to connect familiar concepts to elucidate abstract scientific ideas that they have not yet encountered. Nonetheless, analogy facilitates a more direct comparative analysis, as analogies are explicit, whereas metaphors operate on a more implicit level, necessitating a higher order of cognitive processing from the students. This observation aligns with the findings of Ameyew and Kyere (2018) and Awofodu (2016), who independently noted that both analogy and metaphor instruction contribute positively to student achievement. Conversely, this result contrasts the assertions made by Tsipi (2016), who concluded that students exposed to metaphorical instruction (analogy of form A is B) demonstrated significantly higher achievement levels than those in the analogy group A is like B.

Furthermore, the study revealed that male and female students who engaged with analogy instruction attained almost equivalent outcomes. The comparability in the academic performance of male and female learners taught genetics through analogy may stem from the novelty of this instructional approach, as many educators tend to employ analogies unconsciously, which can mitigate students' apprehensions by facilitating a clearer understanding of genetics through familiar concepts that help to visualize previously abstract genetic principles. Students may achieve a more profound comprehension and insight by attending to the educators' deliberate implementation of analogies and subsequently generating their own. The educational implications of this finding suggest that analogy as a pedagogical strategy can be effectively utilized in coeducational settings. This finding resonates with the conclusions drawn by Nomsoor et al. (2021), who reported an absence of significant differences in the achievements of male and female students instructed in cell division through the gallery-walk pedagogical method.

Additionally, male and female students instructed in genetics through metaphor also exhibited nearly identical mean scores. The t-Test analysis further substantiates that no statistically significant difference exists in the performance of male and female students who received instruction via metaphorical strategies. Using metaphor as an instructional technique engages students' cognitive capacities by explicitly linking familiar concepts to the new knowledge they aspire to acquire. This engagement promotes deeper cognitive processing, thereby facilitating the development of conceptual transformations that enhance their academic performance in genetics. By implication, this suggests that educators in a coeducational classroom environment may employ this instructional approach to facilitate conceptual transformation among both male and female learners. These results are analogous to the findings of Ahmed et al. (2021), who indicated that gender does not significantly impact students' performance in scientific disciplines.

CONCLUSION

This scholarly investigation examined the impact of instructional strategies that utilize analogy and metaphor on the genetics academic achievement of senior secondary students in Ilorin, Nigeria. The analysis of the data revealed that both instructional strategies significantly enhanced student performance in the field of genetics. Moreover, the research findings indicated that neither of the instructional approaches exhibited a bias towards any gender, as the performance of male and female students was comparable when instructed using either strategy. This outcome suggests that the implementation of analogies and metaphors can be effectively applied in a mixed-gender classroom as pedagogical strategies designed to elevate students' academic achievement and facilitate conceptual transformation among learners.

Recommendation

In light of the conclusions derived from the study, the following recommendations are proposed:

1. Educators should utilize analogy and metaphor instructional strategies when teaching genetics and other complex biological concepts that are challenging to comprehend.
2. Analogy and metaphor instructional strategies can be effectively employed by educators within mixed-gender classrooms, given their efficacy as tools to enhance students' academic performance in such environments.
3. These strategies may also be advantageous for instructing other abstract concepts within the disciplines of chemistry and physics.

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