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LEARNING DIFFICULTIES IN GENETICS AMONG SENIOR SECONDARY SCHOOL STUDENTS IN PLATEAU STATE CENTRAL SENATORIAL ZONE

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Abstract

This study investigated learning difficulties in genetics among senior secondary school students in Plateau State Central Senatorial Zone, Nigeria, with respect to gender and school location. Three research questions guided the study, and three hypotheses were tested at a 0.05 level of significance. A descriptive survey research design was adopted. The study population comprised 29,859 SS III Biology students, from which a sample of 540 students was selected using simple random sampling. The sample consisted of 280 male and 260 female students. Data were collected using the Genetics Learning Difficulties Questionnaire (GLDQ), which had a reliability coefficient of 0.87. Findings revealed that students experience varying levels of difficulty in learning genetics, with female students reporting greater learning difficulties than male students, and students in rural schools experiencing more challenges than those in urban schools. The results further indicated

that both gender and school location significantly influence students' perceptions of learning difficulties in genetics. These challenges may be associated with limited access to practical learning experiences, inadequate instructional support, large class sizes, low confidence in handling abstract concepts, and unfavourable socio-educational conditions. Based on the findings, the study recommends that teachers adopt learner-centered, gender-responsive instructional strategies that actively engage students and build their confidence in understanding abstract genetic concepts. It also recommends providing well-equipped biology laboratories and adequate instructional materials, particularly in rural schools, to enhance practical learning and reduce disparities between urban and rural students.

Keywords: Genetics, Learning difficulties, Achievement, Gender, and School location.

Introduction

Advances in science have significantly improved human health, increased life expectancy, enhanced productivity, and supported the development of modern technologies that continue to improve overall quality of life (Anaeto et al., 2016). Science is a systematic body of knowledge concerned with the observation, investigation, and explanation of natural phenomena through evidence-based reasoning and testable explanations. Science education, therefore, focuses on the teaching and learning of scientific knowledge, skills, and processes at various levels, including primary, secondary, and higher education, as well as within the general public (Ugwu, 2014). It integrates scientific content with appropriate pedagogical approaches and elements of other disciplines to enhance effective instruction and meaningful learning (Berube, 2018).

In modern society, where scientific knowledge is a key driver of national development, science education plays a vital role in developing human capacity and advancing technology (Fagerlind & Saha, 2016). Countries invest substantially in science education not only to produce professionals such as scientists, engineers, technologists, and technicians, but also to equip citizens with scientific literacy. This

enables individuals to understand, interpret, and apply scientific knowledge to solve everyday problems and make informed decisions, thereby contributing to sustainable development (Akben, 2020). In Nigerian secondary schools, biology is a core science subject in the science curriculum. It is the study of living organisms, ranging from microscopic cellular structures to complex ecosystems. Biology encompasses various branches, including genetics, which is central to this study. As a practical-oriented discipline, biology is designed to develop learners' scientific inquiry, analytical thinking, and problem-solving skills, which are essential for understanding life processes and addressing real-world challenges.

Quality teaching in biology is essential for developing scientifically literate individuals and supporting sustainable national development. It enhances students' academic achievement, strengthens confidence in the education system, and equips learners with knowledge applicable to key sectors such as medicine, agriculture, and industry. Despite sustained efforts by the Nigerian government and the Science Teachers Association of Nigeria to improve biology education, students' performance in examinations such as the Senior School Certificate Examination (SSCE) conducted by WAEC and NECO has remained consistently poor over the years (Agogo & Naakaa, 2019; Amedu et al.,

2015). This persistent underachievement has serious implications, as success in biology is a major requirement for admission into science-related programmes such as Medicine, Nursing, Veterinary Medicine, Pharmacy, Agriculture, and Genetic Engineering in tertiary institutions in Nigeria.

Within biology, genetics is a core topic taught at the senior secondary school level, particularly in SS3. It is a foundational area that underpins modern advancements in biotechnology, genetic engineering, and medical sciences. In the context of the Fourth Industrial Revolution, genetics has become increasingly important for addressing genetic disorders, advancing gene therapy, and supporting innovations such as DNA testing and genetically modified organisms (Goy et al., 2019; Choden & Kijkuakul, 2020). Despite its importance, genetics remains one of the most difficult areas in biology for students to understand.

Evidence from several studies and examination reports indicates persistent student difficulties in genetics, including misconceptions, poor understanding of genetic processes, and inability to apply genetic principles in problem-solving situations (Onowugbeda, 2020; Abimbola, 2015). WAEC Chief Examiners' Reports (2018–2021) further reveal consistent weaknesses in areas such as genetic crosses,

interpretation of nucleotides, poor use of scientific terminology, and inability to describe genetic processes accurately. These challenges suggest that students struggle with both conceptual understanding and application of genetics, thereby contributing to poor performance in the subject.

Researchers such as Etobro and Fabinu (2017) have argued that understanding students' views on their learning experiences provides valuable insights for improving the teaching and learning of difficult biology topics. In biology education, several empirical studies have consistently identified topics such as genetics, cell division, and cell metabolism as areas of difficulty among students. For example, Buah and Akuffo (2017) and Fauzi and Mitalistiani (2018) reported that learners commonly struggle with mitosis, meiosis, genetic coding, and DNA structure due to their abstract and microscopic nature. Similarly, Salleh et al. (2021) found that students across different contexts share similar perceptions of biology concepts as complex and difficult to understand.

Further empirical evidence from studies by Fauzi and Mitalistiani (2018), Benjamin and Emmanuel (2017), and Hnin and Su (2020) indicates that students' difficulties in genetics are influenced by multiple factors, including learners' attitudes, teaching methods,

availability of instructional resources, and study habits. In addition, Dođru and Özsevgeç (2018) reported that the abstract nature of genetics, differences in learning styles, and negative attitudes toward biology contribute significantly to students' poor understanding of the subject. Retnawati (2022) further emphasized that teacher-centred instructional approaches, inadequate infrastructure, and low student engagement worsen learning outcomes in genetics. The same study also highlighted that students' perceptions of their teachers significantly influence their understanding of complex biological concepts.

Furthermore, Cipkova et al. (2018) found that although many students show positive interest in biology, higher engagement and better understanding are observed among those who actively participate in learning through practical, student-centred activities. This suggests that instructional strategies play a critical role in shaping students' comprehension of difficult biology topics such as genetics. The achievement trends in Biology as recorded by the West African Examination Council (WAEC) in Plateau State between 2020 and 2024 are presented in Table 1.1.

Table 1.1: Statistics of Biology Students' Performance in West African Examination Council (WAEC) (2020-2024) in Plateau State, Nigeria

Year	Number of Candidates Registered	% Credit A1-C6	% Pass D7-E8	% Failed F9
2020	24500	44.03	31.29	24.69
2021	26800	34.08	30.46	35.46
2022	27564	28.30	34.98	36.72
2023	29300	26.94	35.61	37.45
2024	29859	31.52	32.04	36.44

Source: Department of Statistics Education Resource Centre (Jos), Plateau State.

Table 1.1 shows that the percentage of credit passes and above in biology has continued to fall below 50% over the period reviewed. Although grades D7 and E8 are considered passes, they are not sufficient for candidates to gain admission to a tertiary institution to study science courses.

The WAEC Chief Examiners' Reports (2020–2024) consistently attribute students' poor performance in Biology to inadequate teaching materials, insufficient laboratory equipment, ineffective teaching methods, and a shortage of qualified teachers. These

challenges are particularly evident in genetics, which remains one of the most difficult topics for students and a major contributor to overall underachievement in Biology (Retnawati, 2022).

Research evidence indicates that gender plays a significant role in students' attitudes and performance in genetics. Studies by Shin and Shim (2021) and Cipkova et al. (2018) suggest that male students often exhibit higher confidence in solving genetic problems, possibly due to societal expectations and STEM-related stereotypes. In contrast, Appova and Arbaugh (2018) found that female students. However, they may initially experience greater difficulty, often demonstrate higher levels of persistence, and achieve improved outcomes when provided with adequate support. These findings highlight gender-based differences in engagement and learning experiences in genetics.

School location is another critical factor influencing students' achievement in genetics. Research by Fauzi and Mitalistiani (2018) and Retnawati (2022) shows that urban schools are generally better equipped with qualified teachers, functional laboratories, and instructional materials that support effective teaching and learning of genetics. Conversely, rural schools often suffer from inadequate infrastructure,

shortages of trained biology teachers, overcrowded classrooms, and limited access to learning resources. These constraints reduce opportunities for practical engagement and deepen students' difficulties in understanding abstract genetic concepts. Furthermore, Salleh et al. (2021) emphasize that differences in socio-educational support systems between urban and rural communities further widen the learning gap.

According to Benjamin and Emmanuel (2017), both teachers and learners perceive genetics as one of the most challenging topics in Biology, which contributes significantly to persistent poor performance. Against this background, this study seeks to investigate students' learning difficulties in genetics in senior secondary schools in Plateau State, Central Senatorial Zone.

Statement of the Problems

Over the years, students' academic achievement in biology—particularly in genetics—has remained consistently low among senior secondary school students in Plateau State. This persistent underperformance has been widely linked to the inherent difficulty students experience in understanding key genetic concepts. Genetics, as a fundamental component of biology, is often perceived as abstract and complex due to its specialized terminology, symbolic representations, and the integration

of mathematical principles required to solve genetic problems. Many students encounter challenges in interpreting genetic information, translating symbols and diagrams, and establishing meaningful relationships among concepts such as inheritance patterns, gene interaction, and probability. A range of underlying factors further compounds these learning difficulties. Student-related issues, such as weak foundational knowledge and misconceptions, interact with teacher-related factors, including inadequate pedagogical content knowledge and reliance on conventional teaching methods. In addition, instructional constraints such as insufficient teaching aids, limited access to practical and visual resources, and overcrowded classrooms significantly hinder effective teaching and learning. Despite various efforts by educational authorities in Plateau State to improve biology instruction, gaps remain in the availability of qualified teachers, instructional materials, and sustained professional development opportunities.

Moreover, disparities in students' learning experiences based on gender and school location (urban and rural) may also influence the nature and extent of these difficulties. However, empirical evidence in this regard remains limited, particularly within the Plateau State Central Senatorial Zone. Consequently, there is a need for a

comprehensive assessment that not only identifies the specific genetics concepts students find difficult but also examines the underlying causes of these difficulties with respect to gender and school location. Therefore, this study seeks to assess difficult genetics concepts and their underlying causes among senior secondary school students in the Plateau State Central Senatorial Zone, while also examining variations by gender and school location. The findings are expected to provide valuable insights to inform targeted interventions to improve the teaching and learning of genetics in the region.

Objective of the Study

The main purpose of this study was to determine the learning difficulties in Genetics among Senior Secondary School Students in Plateau State Central Senatorial Zone. Specifically, the study ascertained the following:

1. To identify the difficult learning topics in genetics among Senior Secondary School students in Plateau State.
2. To find out the difference in learning difficulties in genetics between male and female students
3. To find out the difference in learning difficulties in genetics between urban and rural students

Research Questions

The following research questions guided the study:

1. What are the difficult learning topics in genetics among students?
2. What are the areas of learning difficulties in genetics between male and female students?
3. What are the areas of learning difficulties in genetics between the urban and rural students?

Research Hypotheses

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

- H₀₁:** There is no significant difference in learning difficulties in genetics between male and female students
- H₀₂:** There is no significant difference in learning difficulties in genetics between urban and rural students
- H₀₃:** There is no significant difference in the areas of learning difficulties in genetics between the urban and rural students.

Methodology

The study employed a descriptive survey design to assess difficult genetics concepts and their underlying causes among senior secondary school students, with respect to gender and school location. The population

comprised all SS III students in public secondary schools in Plateau State Central Senatorial Zone during the 2024/2025 academic session. A multi-stage sampling technique was used: four Local Government Areas were randomly selected, followed by the selection of four schools from each LGA, yielding 16 schools representing both urban and rural locations. Students were then randomly sampled from the selected schools.

Data were collected using a structured instrument titled Genetics Learning Difficulties Questionnaire (GLDQ). The instrument contained two sections: Section A captured demographic variables (gender and school location), while Section B consisted of 27 items grouped into three clusters: difficult genetics concepts, underlying causes, and mitigation strategies. Responses were rated on a 4-point Likert scale (SA = 4 to SD = 1), with a decision-making criterion mean of 2.50. The instrument was validated by three experts in science education and measurement and evaluation, yielding a validation index of 0.87. Reliability was established through a pilot test using Cronbach's Alpha, which produced a coefficient of 0.82. Data were analysed using means and standard deviations to answer research questions, and an independent-samples t-test was used to test hypotheses at the 0.05 level of significance, particularly for gender and school location differences.

Results

Research Question One: What are the difficult learning topics in genetics among students?

Table 1: Mean and Standard Deviation of Learning Difficult Topics in Genetics

S/N	ITEMS	SA	A	D	SD	Mean	SDev	Decision
1	Heredity	190	185	100	65	2.93	1.01	
2	Transmission and Expression of Character in Organisms	195	175	75	95	2.87	1.09	
3	Chromosomes: The Basis of Heredity	185	220	95	90	3.11	1.11	
4	Probability in Genetics	191	230	43	76	2.99	1.00	
5	Application of the Principles of Heredity	179	225	57	79	2.93	1.01	
6	Explanation of terms Cross Fertilization Self-Fertilization Out and In-breeding using Mendelian cross	189	296	40	15	3.22	0.70	
7	Variation Morphological Variation Physiological Variation	255	185	65	35	3.22	0.90	
Mean of Means						3.04		

The data in Table 1 show the level of students' understanding of genetic concepts; the mean scores for the seven items range from 2.87 to 3.22, with an overall Mean of Means = 3.04. Since the acceptance benchmark is 2.50, this indicates that students generally have a moderate understanding of genetic concepts.

H₀₁: There is no significant difference in learning difficult topics in genetics among students

Table 2: t-test Result on Learning Difficulties in Genetics Among Male and Female Students in Plateau State Central Senatorial Zone.

	Gender	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Mean Scores	Male	7	2.3657	.04117	-29.805	12	0.000
	Female	7	3.2414	.06594			

Table 2 shows the t-test results on learning difficulties in genetics among male and female students in the Plateau State Central Senatorial Zone. The mean score for female students (3.2414) is higher than that for male students (2.3657), suggesting that female students experienced greater difficulty in learning genetics than male students. The obtained t-value of -29.805, with a significance level of 0.000, shows that the difference in mean scores is statistically significant. This negative t-value further indicates that the mean difficulty score for male students is significantly lower than that

for female students, thereby rejecting the null hypothesis that there is no significant difference in learning difficulties in genetics between male and female students.

Research Question 2

What are the areas of learning difficulties in genetics between male and female students?

Table 3: Mean and Standard Deviation of Learning Difficulties in Genetics Among Male and Female Students

S/N	ITEMS	Male			Female		
		Mean	SDev	Decision	Mean	SDev	Decision
1	Heredity	2.43	1.08		3.12	0.89	Accepted
2	Transmission and Expression of Character in Organisms	2.36	1.08		3.25	0.85	Accepted
3	Chromosomes: The Basis of Heredity	2.29	1.06		3.19	0.86	Accepted
4	Probability in Genetics	2.37	1.09		3.25	0.83	Accepted
5	Application of the Principles of Heredity	2.38	1.08		3.29	0.79	Accepted
6	Explanation of terms: Cross Fertilization, Self Fertilization, Out-breeding, and In-breeding using Mendelian cross	2.37	1.09		3.28	0.79	Accepted
7	Variation: Morphological Variation, Physiological Variation	2.36	1.07		3.31	0.80	Accepted
	Mean of Means	2.36			3.24		

The results in Table 3 show the areas of learning difficulty in genetics between male and female students. Female students have a substantially higher understanding of genetics than male students. All female mean scores exceed 3.00, whereas male mean scores fall below 2.50 in all items. This clearly indicates a significant gender difference, with females showing stronger comprehension of heredity, chromosomes, genetic probability, variations, and Mendelian crosses.

H₀₂: There is no significant difference in the areas of learning difficulties in genetics between male and female students.

Table 4: t-test Results on the Areas of Learning Difficulties in Genetics Between Students from Urban and Rural Locations.

	Location	N	Mean	Std. Deviation	t-test for Equality of Means		
					t	df	Sig. (2-tailed)
Mean Scores	Urban	7	2.7600	.03830	-31.034	12	0.000
	Rural	7	3.3786	.03625			

Table 4 presents the t-test results on the areas of learning difficulties in genetics between students from urban and rural locations. The mean score for rural students (3.3786) is higher than that of urban students (2.7600), indicating that rural students experienced greater learning difficulties in genetics. The negative t-value (-31.034) further shows that

the mean score of urban students is significantly lower than that of rural students. Since the p-value (0.000) is less than the alpha level of 0.05, the null hypothesis is rejected. This implies that there is a significant difference in the areas of learning difficulties in genetics between urban and rural students.

Research Question 3

What are the areas of learning difficulties in genetics between the urban and rural students?

Table 5: Mean and Standard Deviation of Areas of Learning Difficulties in Genetics Between the Urban and Rural Students

S/N	ITEMS	Urban		Rural	
		Mean	SDev	Decision	Mean 2 Decision
1	Heredity	2.73	1.03		3.38 0.75
2	Transmission and Expression of Character in Organisms	2.70	1.00		3.42 0.76
3	Chromosomes: The Basis of Heredity	2.82	0.99		3.33 0.82
4	Probability in Genetics	2.75	0.99		3.42 0.76
5	Application of the Principles of Heredity	2.77	1.01		3.40 0.76
6	Explanation of terms: Cross Fertilization, Self Fertilization, Out-breeding, and In-breeding using Mendelian cross	2.78	1.02		3.35 0.83
7	Variation: Morphological Variation Physiological Variation	2.77	1.01		3.35 0.83
	Mean of Means	2.76			3.38

Table 5 above shows the areas of learning difficulty in genetics between urban and rural students. Students in rural schools demonstrate a higher understanding of genetics than those in urban schools. Rural mean scores are consistently above 3.30,

while urban mean scores remain below 2.80. This suggests that rural students may be more engaged in the learning process, have greater interest in biology, and receive more consistent instruction in genetics.

H₀₃: There is no significant difference in the areas of learning difficulties in genetics between the urban and rural students.

Table 6: t-test Results on the Areas of Learning Difficulties in Genetics Between Male and Female Students.

	Gender	N	Mean	Std. Deviation	t-test for Equality of Means		
					t	df	Sig. (2-tailed)
MeanScores	Male	10	2.3570	.02497			
	Female	10	3.2910	.01449	-102.315	18	0.000

Table 6 presents the t-test results on the areas of learning difficulties in genetics between male and female students. The mean score for female students (3.2910) is noticeably higher than that of male students (2.3570). This shows that female students reported greater difficulty learning genetics than their male counterparts. The extremely large negative t-value (-102.315) indicates that the mean

score of male students is significantly lower than that of female students. With a p-value of 0.000, which is less than the alpha level of 0.05, the null hypothesis is rejected. This confirms that there is a statistically significant difference in the areas of learning difficulties in genetics between male and female students.

Discussion

The findings of this study revealed a marked difference in learning difficulties in genetics between male and female students in the Plateau State Central Senatorial Zone, with female students experiencing greater challenges than their male counterparts. This outcome underscores the persistent gender gap in science learning, particularly in complex topics such as genetics, which require higher-order cognitive skills and the integration of abstract concepts with practical applications. These results are consistent with earlier studies, including Owolabi (2023), who reported that students' perceptions of difficulty in genetics are influenced by the interaction between instructional methods and personal learning attributes. Similarly, Ezechi (2021) found

that the teaching and learning of genetics in secondary schools are constrained by factors such as the structure of DNA and RNA, genetic crossing, and the methods adopted by teachers, which often disadvantage certain groups of students.

The findings of this study are in disagreement with Hayatu et al. (2023) and Hnin and Su (2020), who emphasized that environmental and instructional factors, including inadequate use of laboratory facilities, limited learning resources, and students' study habits, can exacerbate differences in learning outcomes between male and female students. The findings of this study extend earlier observations by demonstrating that, in the Plateau State context, female students consistently report greater difficulty in genetics, suggesting that gender may mediate

students' engagement, comprehension, and retention of genetic concepts. This aligns with Rani and Ali (2021), who highlighted that differences in learning difficulties among students are often linked to motivational, cognitive, and instructional disparities that may disproportionately affect certain groups. The observed greater learning difficulties among female students could be attributed to multiple interrelated factors. These may include lower confidence or self-efficacy in handling abstract and technical concepts, limited hands-on engagement in practical activities, and environmental or social influences that limit access to learning support. Additionally, instructional approaches that are not gender-sensitive may inadvertently favour male students' learning styles, further widening the gap. This suggests a need for teachers to adopt innovative and inclusive teaching strategies, provide more opportunities for guided practice and collaborative learning, and ensure that classroom resources are effectively utilised to support all students, particularly those who may be more vulnerable to learning difficulties.

The findings of this study indicate a clear difference in the areas of learning difficulty in genetics between students from urban and rural areas in the Plateau State Central Senatorial Zone. Students from rural areas faced greater challenges in understanding genetic concepts than their urban

counterparts. This suggests that location plays a significant role in shaping students' ability to engage effectively with complex topics in biology, particularly genetics.

These results are consistent with prior research emphasizing the influence of environmental and instructional factors on students' learning experiences. Owolabi (2023) noted that inadequate laboratory facilities, limited instructional resources, and ineffective teaching methods significantly affect students' understanding of genetics. Similarly, Ezechi (2021) found that students in rural schools often face challenges due to the lack of qualified teachers, insufficient teaching aids, and limited opportunities for practical activities. Hnin and Su (2020) also observed that students in less-resourced areas struggle more with science learning due to poor study habits, anxiety, and restricted access to instructional support. Collectively, these studies highlight how rural students are at a compounded disadvantage in mastering scientific concepts. The greater learning difficulties among rural students in this study could be attributed to several interrelated factors. Limited access to well-equipped biology laboratories and instructional materials may hinder hands-on learning, which is essential for understanding genetics. Additionally, rural schools may experience shortages of experienced teachers or high student-teacher ratios, which reduce instructional effectiveness. Socioeconomic

constraints, lower parental support, and fewer opportunities for collaborative learning may further limit students' engagement and confidence. These findings underscore the need for targeted interventions, such as the provision of functional teaching aids, teacher capacity-building programs, and the use of inclusive instructional strategies that address the needs of students across different locations.

The findings of this study reveal a clear difference in the areas of learning difficulties in genetics between male and female students in Plateau State Central Senatorial Zone. Female students reported greater challenges in understanding genetic concepts than their male counterparts, suggesting that gender may shape students' experiences with complex biology topics.

This observation aligns with prior research highlighting gender differences in learning difficulties. Owolabi (2023) observed that factors such as teaching methods, inadequate practical experience, and limited engagement can affect students differently, with female students sometimes experiencing greater difficulty. Ezechi (2021) also reported that certain topics in genetics, including the structure of DNA and RNA and genetic crossing, pose challenges to students regardless of gender. Still, female students may feel the impact more intensely due to differences in confidence levels, prior exposure, or study habits. Similarly, studies

by Babayemi, Akpan, and Emah (2018) and Benjamin and Emmanuel (2017) suggest that gender-related differences in learning may be influenced by environmental, instructional, and cognitive factors, which can shape students' perceptions of difficulty and their ability to cope with abstract concepts. The greater learning difficulties reported among female students in this study could be attributed to several interrelated factors. Limited access to practical learning experiences, insufficient instructional support, and lower confidence in handling abstract concepts may contribute to these challenges. Additionally, social and cultural factors, including differential encouragement from parents and teachers, may influence how female students engage with and perceive genetics as a subject. These findings underscore the need for targeted interventions, such as gender-responsive teaching strategies, increased use of practical and visual learning aids, and structured support that enhances students' confidence and engagement in learning genetics.

Conclusion

This study found that senior secondary school students in Plateau State Central Senatorial Zone experience varying levels of difficulty in understanding genetics concepts, with clear differences by gender and school location. Female students reported greater

difficulty than their male counterparts, suggesting possible disparities in confidence, exposure, and engagement with abstract biological concepts. In addition, students from rural schools experienced greater learning difficulties than those in urban schools, largely due to limited instructional resources, inadequate laboratory facilities, and fewer qualified teachers. The findings show that difficulties in genetics are influenced not only by the complexity of the subject matter but also by individual and environmental factors that shape learning experiences. These combined influences result in unequal understanding and performance among students. The study therefore highlights the need for targeted educational interventions, including learner-centred and inclusive teaching approaches, improved access to instructional materials, and strengthened teacher capacity, particularly in rural schools. Addressing these issues is essential for improving students' comprehension of genetics and ensuring more equitable learning outcomes in biology across different groups of learners.

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Recommendation

Based on the study's findings and conclusions, the following recommendations were made.

1. Biology teachers should adopt learner-centered, gender-responsive teaching strategies, such as cooperative learning, guided discovery, and the use of analogies and visual aids, to simplify abstract genetics concepts and improve understanding for both male and female students.
2. School authorities and education stakeholders should ensure adequate instructional resources and functional laboratory facilities, particularly in rural schools, to enhance practical engagement and make genetics concepts more concrete and easier to understand.
3. Government and education agencies should organize regular professional development and retraining programs for biology teachers, focusing on modern pedagogical approaches for teaching genetics, with special attention to addressing learning gaps associated with school location disparities.

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