



Assessing Students' Biology Interests and Perceived Teacher Effectiveness in Rural Communities: Implications for Rural Biology Education

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Abstract: Persistent disparities in science outcomes between rural and urban students highlight the need to better understand how students' interest in Biology and their perceptions of teacher effectiveness interact to shape learning in rural contexts. Maintaining students' interest in Biology requires a clear understanding of the factors that influence their learning outcomes in the subject. The study employed a cross-sectional survey research design to investigate the relationship between teacher effectiveness and Biology interest among rural students. The sample consisted of 227 secondary school students randomly selected from five community schools in Ezeagu, Enugu State, Nigeria. The results indicated that Subject matter mastery is the only significant predictor of students' interest in Biology ($\beta = -.315$, $t = -4.411$, $p = .000$). However, the relationship is negative. Other dimensions of teacher effectiveness did not significantly predict students' interest ($p > 0.05$). This implies that these aspects, as perceived by students, do not independently influence their interest levels in Biology. The study therefore concluded that the affective components of teacher effectiveness play a critical role in enhancing rural students' interest in Biology

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INTRODUCTION

Biology education serves as a cornerstone for scientific literacy and sustainable development because it equips learners with knowledge about life processes and the environment. However, the delivery and effectiveness of Biology education often vary between urban and rural areas due to differences in resources, teacher quality, and learning environments (Adebayo & Olatunji, 2020). The urban rural divide in education is a recurring issue in developing countries, where disparities in infrastructure, access to digital tools, and exposure to innovative teaching methods create unequal learning opportunities for students (Okoli & Ezeudu, 2021).

In urban schools, Biology education tends to benefit from better-equipped laboratories, qualified teachers, and access to modern instructional materials. These advantages often lead to improved academic performance and greater student motivation (Usman & Bello, 2019). Conversely, rural schools frequently struggle with inadequate teaching resources, limited electricity supply, and poor internet connectivity, which hinder the effective teaching and learning of Biology (Eze & Nwosu, 2020). Such inequalities contribute to a performance gap between students in urban and rural settings and can affect students' interest in science-related careers. Moreover, the integration of technology into Biology instruction, such as virtual laboratories and computer-assisted learning, has further widened the gap between urban and rural learners. While urban students often have access to these innovative tools, rural students may still rely on traditional, teacher centered methods (Nwafor, 2022). These disparities highlight the need for educational reforms and targeted interventions aimed at bridging the urban rural gap to ensure equitable access to quality Biology education.

Overtly, research consistently shows that location (rural vs. urban) influences educational outcomes, particularly in science subjects like Biology. Several studies have reported that students in urban schools tend to outperform their rural counterparts in Biology and science related subjects (Abdu 2024, Khan and Khan 2025). Data from comparative assessments indicate that urban students often achieve higher mean scores in Biology performance tests than rural students, suggesting that urban learners benefit from better instructional quality and resource availability (ERIC data analysis, 2024). Similarly, studies in West Africa found that urban schools generally enjoy greater access to facilities and qualified teachers, contributing to better Biology performance compared to rural schools where resources are limited. This disparity has been attributed to a lack of access to high-educational resources (e.g., labs, textbooks, technology) more qualified teachers, poorly equipped laboratories, and fewer learning materials. Nworgu, 2023 further notes that these complex circumstances influence students' interest in Biology.

Ensuring that both urban and rural students receive comparable learning opportunities is essential for achieving educational equity and fostering national development. When Biology education is delivered effectively across regions, it can inspire environmental awareness, promote problem solving skills, and prepare students for participation in the global knowledge economy (Adedokun et al., 2021). As a result, teacher effectiveness may be a powerful element in arousing students' interest in Biology. Thus, addressing the urban rural disparities in Biology education remains a critical

concern for policymakers, educators, and researchers in Nigeria and other developing nations.

Students' interest in Biology represents their level of curiosity, pleasure, and motivation in engaging with the subject. Such interest plays a vital role in Biology learning outcomes because it fosters sustained cognitive engagement and strong emotional involvement in the learning process (Tembe et al., 2020). Consequently, teacher effectiveness may serve as a key factor in stimulating students' interest in Biology. Nevertheless, existing literature provides limited empirical evidence on the relationship between teacher effectiveness and students' interest in Biology within rural contexts.

Teacher effectiveness refers to students' assessment of their teacher's mastery of content, clarity of explanation, classroom management, and ability to inspire learning (Abidoeye & Ogunlowo, 2021). In rural settings, where material and infrastructural resources are scarce, teacher effectiveness becomes even more important because skilled and creative teachers can compensate for resource deficits through innovative teaching methods (Audu, 2018).

Evidence from Nigerian studies indicates a positive correlation between effective Biology teaching and improved student understanding of concepts (Neji et al., 2019). Strategies such as ethno-biology integrating local environmental and cultural resources into teaching have significantly enhanced student retention and interest in rural schools (Mbaegbu & Osuafor, 2023). Despite the recognized importance of Biology in equipping learners with scientific knowledge and practical skills, many rural students in Nigeria underperform in the subject. This is often linked to low student interest and inadequate teaching practices, compounded by limited facilities and resources. While several studies have examined teacher effectiveness and student achievement in urban and mixed school settings, there is limited empirical evidence focused specifically on rural communities where unique socio-economic and infrastructural challenges exist. Furthermore, there is need to understand how students in rural schools perceive their Biology teachers and how such perceptions relate to their interest in the subject. Without this understanding, efforts to improve rural Biology education may lack precision and fail to address the root causes of poor performance and disengagement.

Given these realities, assessing students' interest in Biology and their perception of teacher effectiveness in rural communities is vital. Such assessment can inform targeted interventions for improving the quality of Biology education in these contexts, thereby enhancing students' performance, motivation, and readiness for science related careers.

Perceived Teacher Effectiveness and Biology Learning in A Rural Setting

Teacher effectiveness is a critical determinant of students' academic success, particularly in science subjects like Biology. In rural settings, where educational resources and learning environments are often limited, students' perceptions of their teachers' effectiveness play a significant role in shaping their motivation, engagement, and achievement (Okeke & Eze, 2020). Perceived teacher effectiveness refers to students' evaluation of their teachers' ability to organize lessons, communicate clearly, motivate

learners, and employ appropriate instructional strategies to facilitate understanding (Audu & Yusuf, 2019). When students perceive their teachers as competent and supportive, they are more likely to develop a positive attitude towards learning Biology, even in resource constrained environments.

In many rural schools, however, teacher effectiveness is often constrained by systemic challenges such as inadequate laboratory facilities, large class sizes, limited access to instructional materials, and insufficient professional development opportunities (Ogunleye & Adeyemo, 2021). These factors can hinder teachers from adopting student-centered pedagogies or integrating practical experiences that make Biology concepts meaningful. Consequently, students may view their teachers as less effective, leading to lower interest and performance in the subject (Ezeanya & Nwankwo, 2022).

Perceived teacher effectiveness also influences the classroom climate, which in turn affects students' learning outcomes. Effective teachers in rural contexts often employ improvisation techniques, local examples, and participatory methods to enhance understanding despite resource shortages (Achor & Nworgu, 2018). By doing so, they foster a supportive learning environment that encourages curiosity, critical thinking, and problem-solving skills among students. Conversely, teachers who rely solely on rote teaching methods or exhibit low enthusiasm tend to create passive learning conditions, thereby limiting students' interest in Biology (Enebechi and Menkiti, 2021).

Improving teacher effectiveness in rural settings requires continuous professional development, mentorship, and motivation for teachers. When teachers feel empowered and supported, they are better positioned to deliver engaging lessons that promote conceptual understanding of Biology (Okafor, 2021). Thus, enhancing teacher effectiveness is essential for bridging the educational gap between rural and urban schools and for ensuring that all students, regardless of location, have access to quality Biology education.

Interests in Biology of Students in Rural Communities

Interest is a feeling of Curiosity, attention, or concern that motivates individuals to engage with certain activities, subjects, or experiences. Interest plays a crucial role in learning and personal development, as people are more likely to invest time and efforts in areas, they find appealing or enjoyable. When students manifest interest in a subject, they focus more on the work, gain more skills, and are better equipped to face challenges emanating from the subject (Enebechi, 2023). Interest in learning a subject such as Biology involves a learner's positive feelings, value for the subject, and willingness to engage in related activities. In the rural secondary school context, interest is not only about liking Biology, but also about perceiving its relevance to learners' lives, local environment and future prospects (Awosika & Okoli, 2023). Interest as a psychological construct, refers to an individual's curiosity or enthusiasm for a particular subject or activity. In the educational context, interest plays a critical role in motivating students to engage actively with learning materials, persist through challenges, and achieve better outcomes. Interest, according to the researcher's point of view, refers to the students'

level of curiosity, attention, enthusiasm, and positive emotional response towards learning Biology, as influenced by the instructional technique used. Interest in learning a subject such as Biology involves a learner's positive feelings, value for the subject, and willingness to engage in related activities (Hidi & Renninger, 2006, as cited in Renninger & Hidi, 2016). In rural secondary school context, interest is not only about liking Biology, but also about perceiving its relevance to learners' lives, local environment and future prospects (Awosika & Okoli, 2023).

Some evidence suggests that, contrary to assumptions, rural students can express high interest in Biology when instruction is relevant and experiential. For example, a study found that in a rural setting a field-trip strategy produced a greater mean gain in interest for rural students (mean gain = 0.94) compared to urban peers (mean gain = 0.55) when teaching ecology. However, findings regarding the Biology interest of rural and urban students have been inconsistent.

Purpose of the Study

The main purpose of this study is to assess students' interest in Biology and their perception of teacher effectiveness in rural communities, specifically, the study seeks to:

1. Determine the level of students' interest in Biology in rural secondary schools.
2. Assess students' perception of Biology teacher effectiveness in rural communities.
3. Examine the relationship between students' interest in Biology and the dimensions of teacher effectiveness.

Research Questions

The following research questions guided the study and was tested at 0.05 level of significance

1. What is the level of Biology interest among students in rural secondary schools?
2. How do rural students perceive the effectiveness of their Biology teachers?
3. What is the relationship between students' interest in Biology and the dimensions of their perception of teacher effectiveness?

Research Hypothesis

Ho₁: There is no significant relationship between students' interest in Biology and the dimensions of their perception of teacher effectiveness

METHODS

Research Design

The design for this study was correlation research design, which aimed to describe and measure the degree of relationship between two or more variables (Devi et al., 2022). This design is suitable for this study because it sought to predict the relationship between teacher effectiveness and students' interest in Biology in rural public secondary schools in Enugu State.

Participants

Our respondents consisted of 227 randomly sampled senior secondary II students from five public secondary schools in five rural communities in Enugu State.

Instrument for Data Collection

In this study, two major instruments were employed for data collection. The first instrument was the Academic Interest Scale for Adolescents (AISA), a comprehensive multidimensional tool developed by Luo et al. (2019) to assess students' academic interest across various subject areas. The instrument consists of 30 items rated on a four-point Likert scale ranging from Strongly Agree (SA) to Strongly Disagree (SD). The scale is grounded in Hidi and Renninger's (2006) four-phase model of interest development, encompassing four domains: emotion, value, knowledge, and engagement. For the present study, the AISA demonstrated a high level of internal consistency, with a Cronbach's alpha coefficient of 0.87 for the Biology related items.

The second instrument used was the Teacher Effectiveness Questionnaire (TEQ), a 75-item scale developed by the researchers. It utilized a four-point rating scale: Strongly Disagree (SD), Disagree (D), Agree (A), and Strongly Agree (SA). The development of the TEQ was informed by an extensive review of relevant literature and theoretical frameworks. Foundational studies that guided the construction of the scale include those by Macia and Sánchez (2015), Meng et al. (2012), Moreno-Murcia et al. (2015), and Swathi (n.d.) to frame the TEQ. The TEQ was designed to reflect the multidimensional nature of teacher effectiveness. It comprises five clusters: subject matter mastery (15 items), culturally responsive instruction (15 items), student-teacher relationship (15 items), effective classroom management (15 items), and efficient use of instructional materials (15 items). The Cronbach's alpha reliability coefficients for these clusters were 0.96, 0.93, 0.87, 0.85, and 0.92 respectively, indicating excellent internal consistency across all subscales.

Method of Data Collection and Analysis

The data collection process followed the ethical standards for research in the behavioral sciences and complied with the principles outlined in the 1964 Helsinki Declaration. Before commencing the study, the researcher explained the objectives of the research to the school authorities and obtained their permission to conduct the investigation within their schools. The students were also briefed on the purpose of the study, emphasizing that their participation was purely for academic and research purposes. Participation was entirely voluntary, and no personal identifiers such as names or sex were requested in order to maintain confidentiality. All data were stored securely on a password-protected computer accessible only to the researchers.

With assistance from the teachers, the questionnaires were distributed to students during regular school hours. Forty five students were randomly selected from four schools while 47 students were equally randomly selected from the fifth school bearing in mind that the population differs. This gave a total of 227 participants. Questionnaires were collected immediately from students who completed them on the

spot, while teachers assisted in retrieving those from students who requested more time. All the questionnaires were 100% completed and returned.

For data analysis, we employed the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics such as mean and standard deviation were used, along with regression analyses, to address the research questions and test the study's hypotheses at a 0.05 level of significance.

RESULT AND DISCUSSION

Research Question One

What is the level of Biology interest among students in rural secondary schools?

Table 1. Mean and Standard Deviation Scores in Level of Biology Interest among Students in Rural Secondary Schools

S/N	Item Statement	N	Mean	Std. Deviation	Decision
1	I look forward to my Biology lessons every week	227	3.2115	1.0215	Accepted
2	I enjoy reading Biology textbooks and materials in my free time	227	2.6035	0.94615	Accepted
3	I participate actively in Biology class discussion	227	3.2467	0.91735	Accepted
4	I feel excited when learning new Biology topics	227	2.5463	1.08543	Accepted
5	I often share what I learn in Biology with friends or family	227	3.1630	0.95234	Accepted
6	I enjoy practical work in the Biology laboratory	227	2.3568	0.89269	Not Accepted
7	I like answering Biology questions even when they are difficult	227	3.0044	0.92410	Accepted
8	I would like to have a career related to Biology	227	2.8414	0.89317	Accepted
9	I search for Biology information on the internet or in books outside class	227	2.8767	0.94669	Accepted
10	I enjoy drawing or labelling Biology diagrams	227	2.5133	0.87040	Accepted
11	I feel motivated to study Biology even without teacher supervision	227	3.1366	0.78922	Accepted
12	I take pride in doing well in Biology assignments and tests	227	3.0132	0.83867	Accepted
13	I enjoy relating Biology lessons to things in my environment	227	3.1982	0.74096	Accepted

14	I enjoy group work in Biology projects	227	2.3436	0.92936	Accepted
15	I am curious about how living things function	227	3.2819	0.57205	Accepted
16	I enjoy visiting places like farms, gardens, or zoos to observe living organisms	227	3.1894	1.06192	Accepted
17	I discuss Biology topics with my classmates after lessons	227	2.5727	1.06752	Accepted
18	I like doing extra Biology exercises at home	227	2.9780	1.18786	Accepted
19	I get excited when we have Biology experiments	227	2.5022	0.94716	Accepted
20	I like applying Biology knowledge to solve real-life problems	227	3.1718	0.94611	Accepted
21	I feel confident when answering Biology questions in class	227	2.3524	1.09263	Not Accepted
22	I look for television or radio programmes related to Biology	227	2.9824	0.95919	Accepted
23	I like helping my friends understand Biology concepts	227	2.9427	0.69210	Accepted
24	I find it interesting to connect Biology to other science subjects	227	2.7181	1.00432	Accepted
25	I keep neat and complete Biology notes	227	2.2832	0.95656	Accepted
26	I enjoy using charts and models to learn Biology	227	2.9692	0.90423	Accepted
27	I like participating in school science clubs or Biology competitions	227	3.0088	0.61681	Accepted
28	I enjoy observing plants and animals in my surroundings	227	3.2643	0.77042	Accepted
29	I take interest in knowing how the human body works	227	2.3524	1.05555	Not Accepted
30	I would miss Biology lessons if I were absent from school	227	2.7709	0.75869	Accepted
Weighted Mean and Standard Deviation		227	2.8465	0.91137	Accepted

N = 227

The result in table 1 when compared with the weighted mean score of 2.8465 and standard deviation of .91137, shows the level of Biology interest among students in looking forward for Biology lessons every week (M= 3.2115; S.D 1.0215), reading Biology textbooks and materials at free time (M= 2.6035; SD =.94615), participating actively in Biology class discussion (M = 3.2467; S. D =.91735), excitement when learning new Biology topics (M = 2.5463; S.D= 1.0854), sharing Biology knowledge with friends or

family (M= 3.1630; S.D =.95234), enjoying practical work in Biology laboratory (M= 2.3568; S.D = .89269), answering Biology questions even when they are difficult (M= 3.0044; S.D = .92410), having a career related to Biology (M = 2.8414; S.D = .89317), searching for Biology information on the internet or in books outside of class (M= 2.8767; S.D = .94669), drawing or labeling Biology diagrams (M= 2.5133; S.D =.87040), motivation to study Biology even without teacher supervision (M= 3.1366; S.D =.78922), pride in doing well in Biology assignment and test (M = 3.0132; S.D = .83867), relating Biology lessons to things in the environment (M= 3.1982; S.D = .74096), group work in Biology project (M= 2.3436; S.D = .92936), curious on how living things function (M= 3.2819; S. D = .57205), visiting places like farms, garden or zoos to observe living organisms (M = 3.1894; S.D = 1.06192), discussion of Biology topics with classmates after lessons (M= 2.5727; S.D = 1.06752), doing extra Biology exercises at home (M = 2.9780; S.D =1.18786), excitement in Biology experiments (M = 2.5022; S. D =.94716) application of Biology knowledge to solve real life problems (M = 3.1718; S.D =.94611), confident in answering Biology questions in class (M= 2.3524; S. D = 1.09263), television or radio programs related to Biology (M = 2.9824; S.D= .95919), helping friends understanding Biology concept (M= 2.9427; S.D = .69210), connecting Biology to other science subject (M = 2.7181; S.D =1.00432), neat and complete Biology note (M= 2.2832; S. D = .95656), using of charts and models to learn Biology (M = 2.9692; S.D =.90423), participating in school science clubs or Biology competitions (M = 3.0088; S. D .61681), observing plants and animals in surroundings (M= 3.2643; S. D = .77042), knowing how the human body works (M= 2.3524; S.D= 1.05555), missing Biology lesson if absent from school (M = 2.7709; S.D = .75869). More so, the low weighted standard deviation score of .91137 indicates that the students' level of interest in Biology did not deviate much in perceived teachers' effectiveness in rural communities.

Research Question Two

How rural students do perceived the effectiveness of their Biology teachers?

Table 2. Regression Analysis of How Rural Students Do Perceived the Effectiveness of Their Biology Teachers

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.347a	.347a	.096	5.84052

a Predictors: (Constant), Efficient Use of Instructional Materials, Subject Matter Mastery, Effective Classroom Management, Culturally Relevant Instruction, Student Teacher Relationship.

Table 2 shows how rural students do perceived the effectiveness of their Biology teachers as .347a. This indicates that there exists a moderate positive relationship between students' interest and perceived teachers effectiveness. The data in the table

also revealed that the coefficient of determination (r^2) associated with the correlation coefficient of .347a is 120. The coefficient of determination (r^2) indicates that 12.0% variation in students' interest in Biology can be attributed to perceived teachers effectiveness while 88% of the variance can be attributed to other factors not considered by this study.

Research Question Three

1. What is the Relationship Between Students' Interest in Biology and the Dimensions of Their Perception of Teacher Effectiveness?

The multiple regression analysis was conducted to determine the extent to which the dimensions of students' perception of teacher effectiveness: Subject Matter Mastery, Culturally Relevant Instruction, Student Teacher Relationship, Effective Classroom Management, and Efficient Use of Instructional Materials) predict students' interest in Biology

The multiple regression results (Table 2) show that among the five teacher-effectiveness dimensions tested, Subject-Matter Mastery was the only statistically significant predictor of student interest ($\beta = -.315$, $t = -4.411$, $p = .000$). All other predictors: Perception of Teacher Effectiveness (aggregate; $\beta = .008$, $p = .935$), Culturally Relevant Instruction ($\beta = .000$, $p = .997$), Student-Teacher Relationship ($\beta = .062$, $p = .465$), Effective Classroom Management ($\beta = -.034$, $p = .658$), and Efficient Use of Instructional Materials ($\beta = .078$, $p = .360$) were not statistically significant at $\alpha = .05$.

Two points are important to emphasize: (1) the magnitude of Subject-Matter Mastery's standardized coefficient ($\beta = -.315$) shows it has the strongest relationship among the predictors, and (2) the negative sign is unexpected given the literature that usually links teacher content competence with positive student attitudes. Many studies report a positive association between perceived teacher competence (including knowledge of subject matter) and student interest or achievement; in other words, when students perceive their teachers as knowledgeable, interest commonly increases.

Table 3.
Dimensions of Teacher Effectiveness as Predictors of students' interest in Biology

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	92.698	6.237		14.863	.000
Dimensions of teacher effectiveness					
SUBJECT MATTER MASTERY	-.368	.084	-.315	-4.411	.000
CUITURALLY RELEVANT INSTRUCTION	.000	.100	.000	.004	.997
STUDENT TEACHER RELATIONSHIP	.060	.082	.062	.731	.465

EFFECTIVE CLASSROOM MANAGEMENT	-.028	.064	-.034	-.443	.658
EFFICIENT USE OF INSTRUCTIONAL MATERIALS	.060	.066	.078	.917	.360

a. Dependent Variable: Interest

Research Hypothesis

There is no significant relationship between dimensions of teacher effectiveness and students' interest in Biology.

In table 2 it was observed that Subject matter mastery had a beta of .315. This indicate that subject matter mastery contributes 31.5% to students interest in Biology in rural communities and at 0.05 level of significant, the calculated t 4.411, P value is .000 the null hypothesis is not accepted. Culturally relevant instruction had beta of .000. This indicates that culturally relevant instruction contributes 0% to students interest in Biology in rural communities and at 0.05 level of significant, the calculated t .004, P value is .997 the null hypothesis is accepted. Student teacher relationship had a beta of .062. This indicates that student teacher relationship contributes 6.2% to students interest in Biology in rural communities and at 0.05 level of significant, the calculated t .731, P value is .465 the null hypothesis is accepted. Effective classroom management had a beta of .034. This indicates that effective classroom management contributes 3.4% to students interest in Biology in rural communities and at 0.05 level of significant, the calculated t .443, P value is .658 the null hypothesis is accepted. Efficient use of instructional materials had a beta of .078. This indicates that efficient use of instructional materials contributes 7.8% to students interest in Biology in rural communities and at 0.05 level of significant, the calculated t .917, P value is .360 the null hypothesis is accepted.

Discussion

The study examined students' Biology interests in rural areas and their perceived teacher effectiveness, as well as how perceived teacher effectiveness is associated with students' Biology interests. Findings on the level of Biology interest among students in rural secondary schools revealed that students in rural secondary schools possess an appreciable level of interest in Biology despite some challenges that may hinder their full engagement. The moderate interest level may reflect a mix of enthusiasm toward Biology concepts and limited exposure to interactive or laboratory-based learning experiences. According to Okebukola (2022), effective engagement in science subjects, particularly Biology, depends largely on the quality of learning experiences provided by teachers and the availability of instructional resources.

The findings agree with Akinyemi and Okoro (2024), who reported that students' interest in Biology is typically moderate in Nigerian rural schools due to inadequate laboratory facilities, minimal technological integration, and limited practical activities. Similarly, Adu and Salami (2023) emphasized that learners' enthusiasm for Biology often declines when instruction is overly theoretical and lacks real-life contextualization. This

suggests that fostering higher interest among rural students may require more experiential and learner-centered teaching methods.

In line with Bandura's (1997) social cognitive theory, student interest is a product of the interaction between environmental and personal factors. Therefore, while the findings indicate positive affective disposition, the moderate mean scores highlight the need for improved instructional strategies that can sustain intrinsic motivation and deepen understanding.

In addition, the findings on how rural students perceive the effectiveness of their Biology teachers suggest that students who perceive their Biology teachers as effective tend to show higher levels of interest in the subject. However, the relatively small R^2 value implies that teacher effectiveness alone may not be the predominant determinant of student interest. This aligns with the study by Aminu, Usman, and Aluko (2022), which found that teacher related variables contributed modestly to students' affective outcomes compared to environmental and socio economic factors.

Furthermore, Eze and Ogbu (2023) noted that while teacher competence enhances student understanding, other dimensions such as peer influence, availability of learning materials, and relevance of instruction play crucial roles in sustaining interest. In the same vein, Adu and Salami (2023) observed that teacher effectiveness influences cognitive performance more strongly than it affects interest or motivation.

The implication of these findings is that enhancing student interest in Biology requires a multi-dimensional approach that integrates teacher quality with supportive learning environments, accessible resources, and innovative teaching strategies. Particularly in rural settings, where exposure to laboratory experiences and digital tools is limited, Biology teachers must adopt context-driven pedagogies that connect classroom lessons to real-life experiences (Okebukola, 2022).

Moreover, the multiple regression analysis examined how five dimensions of teacher effectiveness: Subject Matter Mastery, Culturally Relevant Instruction, Student Teacher Relationship, Effective Classroom Management, and Efficient Use of Instructional Materials jointly and individually predict students' interest in Biology. The significant yet negative relationship between subject matter mastery and students' interest suggests a complex dynamic. It may indicate that while teachers possess deep knowledge of Biology content, their delivery methods may not sufficiently engage students or make learning relatable. This observation supports Adedokun and Udo (2021), who found that high teacher expertise can sometimes lead to overly abstract instruction, creating a gap between teacher presentation and student comprehension.

Moreover, the non-significant effects of other teacher effectiveness dimensions highlight the growing need for affective and contextualized pedagogy in science classrooms. Adeyemi and Akinwale (2024) argued that emotional engagement and classroom relationships significantly influence how students internalize and enjoy science learning. Hence, Biology teachers must balance cognitive rigor with interactive, inquiry-based, and culturally relevant strategies that resonate with students' lived experiences. The findings corroborate Ibrahim and Alade (2024), who reported that students' interest in science is increasingly driven by exposure to technology-mediated

learning environments such as virtual laboratories and online tutorials. These platforms foster autonomy and curiosity, particularly in rural settings where conventional resources may be scarce.

In summary, while teachers' mastery of content remains critical, interest in Biology thrives when learning becomes participatory, relevant, and emotionally engaging. The results thus reaffirm Bandura's (1997) principle that environmental reinforcement and self-efficacy jointly shape student motivation and persistence.

Furthermore, the acceptance of the null hypothesis is consistent with findings by Adams and Mensah (2023), who established that teacher effectiveness indicators, though essential for cognitive achievement, exert limited influence on affective learning outcomes like interest and motivation. Similarly, Aminu et al. (2022) found no significant relationship between teacher evaluation scores and students' enthusiasm for science in rural Nigerian schools.

However, the negative contribution of subject matter mastery demands careful interpretation. Adeyemi and Akinwale (2024) explained that when instruction becomes excessively content-heavy, students may feel overwhelmed, leading to reduced engagement. Therefore, effective teaching should integrate affective support, student participation, and practical application to stimulate interest.

This study has contributed meaningfully to existing knowledge. To begin with, it addressed the gap in the literature concerning the influence of teacher effectiveness on the Biology interests of students in rural communities in Nigeria. By disaggregating teacher effectiveness into its constituent components, the study provided clearer insight into which aspects require greater emphasis in promoting students' interest in Biology in rural settings.

Conclusions and implications for Rural Biology Education

In summary, the findings reveal that among all the dimensions of perceived teacher effectiveness examined; only subject matter mastery significantly influenced students' interest in Biology and the relationship was negative. Other components, including culturally relevant instruction, classroom management, and teacher student relationship, showed no statistically significant impact. This suggests that students' interest in Biology may not rely solely on perceptions of teacher effectiveness but also on pedagogical, contextual, and motivational factors that shape classroom experiences.

Educational Implications

1. Teacher training programs should emphasize affective and experiential pedagogies, not only content mastery.
2. Curriculum planners should promote contextual and culturally responsive Biology instruction, especially for rural learners.
3. Schools should invest in interactive teaching aids, digital resources, and low-cost laboratory innovations to enrich student experiences.
4. Regular professional development should encourage teachers to blend cognitive depth with emotional and technological engagement strategies.

Summary of Findings

1. Students in rural secondary schools demonstrated a moderate level of interest in Biology (weighted $M = 2.8465$; $SD = .91137$).
2. A moderate positive correlation ($R = .347a$) exists between students' perception of teacher effectiveness and their interest in Biology, explaining 12% of the variance.
3. Among the teacher effectiveness dimensions, only subject matter mastery significantly predicted interest in Biology, and the relationship was negative.
4. The null hypothesis was accepted, indicating no significant overall relationship between perceived teacher effectiveness and student interest in Biology.

Limitations and Recommendations

The data are cross-sectional and based on student self-report, so causal inferences are not warranted; perceptual measures may conflate competence with instructional style; the regression model explained only 12% of variance, indicating missing predictors (e.g., prior grades, home factors, school resource indices, and self-efficacy). Also, the negative coefficient for Subject-Matter Mastery should be interpreted cautiously and triangulated with classroom observation or teacher self-reports in future work.

Recommended next steps for research: conduct classroom observations to distinguish knowledge competence from pedagogical style; include measures of student self-efficacy, prior achievement and school resource indices in the model; consider longitudinal designs or quasi-experimental interventions that combine subject knowledge with active methods to test causal pathways.

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