



## Formative Assessment Practices as a Predictor of Secondary School Students' Academic Achievement in Biology in Makurdi Local Government Area

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### Abstract

The study investigated formative assessment practices as a predictor of secondary school students' academic achievement in biology. Two each of; research questions and hypotheses guided the study. The study adopted the correlational research design with a population of 840 SS II biology students and a sample size of 271. Instruments used are: Formative Assessment Practices Questionnaire and Biology Achievement Test and were face validated by three experts. Reliability indices of 0.72 was obtained for FAPQ using Cronbach alpha and 0.82 for BAT using K-R20. Data collected were analyzed using regression analysis and moderation analysis with Andrew Hayes Process Macro. The findings revealed that the predictive power of formative assessment practices on secondary school student's academic achievement in biology is statistically significant as well as when moderated by gender. The study recommended that school administrators should prioritize the integration of formative assessment practices in schools.

**Keywords:** achievement, assessment practices, formative assessment

### Introduction

Assessment has been a major concept in the educational sector as it plays a crucial role in helping to measure students' learning outcomes and inform instructional practices. According to Orheruata and Oyakhirome (2019), Assessment is defined as a cornerstone in education that facilitates the measurement of students' learning outcomes and guiding instructional practices. It serves as a means for teachers to update their understanding of students' progress and adjust their teaching methods accordingly (Orheruata & Oyakhirome, 2019). Kartal (2022) describes assessment as a multifaceted process involving the collection, evaluation, and utilization of evidence regarding students' learning for various purposes, such as diagnosing strengths and weaknesses, monitoring progress, assigning grades, and providing feedback.

Various assessment methods, including paper-and-pencil tests, performance evaluations, observations, and interviews, are utilized by teachers to gather information about students' learning (Orheruata & Oyakhirome, 2019). This information serves multiple

functions, including providing feedback to students, aiding decision-making processes, enhancing a

supportive classroom environment, and diagnosing potential learning challenges (Joshua, 2013). Orheruata and Oyakhirome (2019) further detail the three main types of assessment: placement, formative, and summative. Placement assessments evaluate students' prior knowledge before instruction, while formative assessments identify learning difficulties during instruction, allowing teachers to make adjustments. Summative assessments, conducted at the end of instruction, evaluate students' overall achievement against program objectives. Formative assessments provide immediate feedback for ongoing improvement, helping students understand the subject matter better and supporting continuous learning. Summative and placement assessments are retrospective, focusing on final outcomes or initial placement. Prioritizing formative assessment during teaching promotes educational experiences and improves students' achievement in biology (Andersson & Palm, 2018).

Every teacher's objective in the classroom should be to support their students' increasing learning



achievement and competence. When evaluating pupils in the classroom, a teacher should be primarily concerned with improving learning and achievement rather than just compiling data in order to give grades or certify mastery. Formative assessment is perhaps most important when this is the main focus. Formative assessments, according to Glazer (2014), entail assignments that provide students with feedback on how they performed during the semester. Formative evaluation benefits teachers and pupils alike, claims Ojugo (2013). It assists in identifying the precise difficulties students encounter in a subject, identifying alternate remedial tactics, and diagnosing students' learning obstacles. Additionally, it foresees the most effective methods of instruction to aid students in understanding these difficulties and improving all areas of academic achievement, including biology.

Biology provides students with a foundational understanding of science by examining the morphology, physiology, and evolution of living things, as well as their interactions with non-living elements of the environment. In domains like biochemistry and biophysics, it integrates concepts from physics, medicine, and chemistry to provide a thorough understanding of life and its interactions with the environment (Joshi, Heyner & Green, 2023). This multidisciplinary approach aids scientists in tackling challenging issues in life and producing creative fixes. Furthermore, further education and employment in the medical sciences, pharmaceuticals, environmental biology, biotechnology, agriculture, and food sciences all require a solid understanding of biology (Onu, Anyaegbunam & Uzoigwe, 2020). Knowing biology—especially genetics—also helps with decision-making, such as selecting a life mate, and offers insights into human characteristics (Nurse & Hayles, 2019). Furthermore, the use of biology in agriculture greatly improves food distribution and production, which raises food security (Pawlak and Kołczyński, 2020). Students in senior secondary school must receive high marks in this subject due to its importance to society.

An accomplishment is something that has been attained by hard work, talent, experience, or persistence. Academic achievement is defined by Mimrot (2016) as performance outcomes that show how well particular objectives have been met in learning environments. It is a measurement of the skills that students have acquired during instruction and learning activities, according to Danjuma (2015). Academic accomplishment is quantified by scores, grades, grade

point averages, and ranks, which show the extent and quality of learning (Onukwufor & Ugwu, 2017). In the realm of education, academic accomplishment is crucial, particularly in subjects like information, communication, and technology (ICT), mathematics, chemistry, physics, and, most importantly, biology that deal with human existence and preservation.

Regretfully, we have seen that biology students' academic performance does not meet the requirements needed for national influence, the preservation of human life, and many other applications to the many elements of existence. The chief examiner's report for the West African Senior School Certificate Examination (WASSCE) reveals that students' performance in biology has consistently fallen short of expectations. According to the report, in 2016, 2017, 2018, 2019, 2022, and 2023, students' mean achievement and standard deviation scores were 26 (12.61), 31 (10.91), 30 (9.00), 31 (9.43), 37 (9.54), and 31 (10.91), respectively. During the periods under review, the average achievement score of the students is less than half of the highest possible mark in biology. This would suggest that biology students' performance was continuously lacking.

Numerous research have been carried out recently to address the problem of low success in biology. A lack of appropriate instructional materials (Ihejiamaizu & Ochui, 2019), the use of ineffective teaching methods (Ezenwosu & Nworgu, 2013; Okoyefi, 2014), teachers' instructional strategies (Onu, Anyaegbunam & Uzoigwe, 2020), and an overloaded biology syllabus (Osuafor & Okigbo, 2013) are just a few of the factors that these studies have identified as contributing factors to low achievement in biology. The issue nevertheless exists in spite of these attempts to lessen the danger of subpar biology performance. This has raised questions among those involved in education about what might be causing the biology achievement gap to remain. Additionally, Akintola & Odewumi (2021) have determined that one of the main causes of students' subpar performance on biology exams is bad assessment procedures used by Nigerian teachers at the senior secondary school level, particularly in formative assessment.

With and for students, teachers participate in formative assessment procedures. Formative assessment procedures, according to Almahal, Osman, and Tahir (2023), entail regular, interactive assessments with the goal of comprehending students' development and modifying instruction accordingly. Both assessment as learning and assessment for learning are



included in this type of evaluation. Formative assessment has the potential to improve student learning outcomes and foster a deeper comprehension of the subject matter, whether it is utilized as a tool for learning or as a means of learning itself (Wiliam, 2018). But there are obstacles to its successful application, like people mistaking its intent for nothing more than a summative assessment, which results in subpar performance (Wiliam, 2018). Higher academic attainment is probably what will happen if teachers understand the function and nature of formative assessment better.

Teachers must devote a significant amount of time and energy to implementing formative assessment procedures in today's classrooms. According to Chappuis (2015), educators do not devote enough time and energy to formative assessment techniques, which call for more time and effort in order to gather, analyze, and use data effectively. This is another significant obstacle to the use of formative assessment. Because of these flaws in formative assessment procedures, researchers have been working to improve academic attainment in biology by finding the best ways to utilize these strategies and tackling other concerns including gender inequalities in science. The subject of gender disparities in science has long been discussed in the literature. Some studies claim that the gender gap in science subjects especially biology has caused a great deal of controversy among academics. According to a study by Jia, Yang, and Qian (2020), boys often perform better than girls in science, which is consistent with Amedu's (2015) results that gender has a big impact on students' academic performance. These outcomes, however, go counter to those of Nwankwo and Achufusi (2019), who found no gender differences in conceptual change and retention scores in physics. In a similar vein, Ihenko (2017) offered empirical proof that gender has no appreciable bearing on scientific accomplishment. These contradictory data highlight the need for more research on how gender affects students' performance in a subject like biology. According to recent research findings, many strategies are being used to address the issue of low academic achievement, which is caused by things like ineffective teaching methods, inadequate teaching resources, and instructional strategies. But difficulties pertaining to assessments, especially formative assessments, have come to light. This could be a contributive factor to poor achievement in biology. "It is on this note that the study seeks to investigate formative assessment practices as

predictor of secondary school students' achievement in biology.

### Research Questions

1. What is the predictive power of formative assessment practices on students' academic achievement in Biology?
2. What is the predictive power of formative assessment practices on students' academic achievement in Biology as moderated by gender?

### Research Hypotheses

- H0<sub>1</sub>:** There is no significant predictive power of formative assessment practices on students' academic achievement in Biology.
- H0<sub>2</sub>:** There is no significant predictive power of formative assessment practices on students' academic achievement in Biology as moderated by gender."

### Method

The study utilized a correlational research design with a population of 840 SSII students from eight coeducational schools in Makurdi Local Government Area. A sample size of 271 (154 male and 117 female) SSII biology students was determined using the Taro Yamane formula and selected through a multi-stage sampling process. Initially, a simple random sampling technique was employed to choose six coeducational public schools in Makurdi using the slips-of-paper method to ensure equal selection chances for all schools. Proportionate sampling was then applied to determine the representative sample size for each selected school, accurately reflecting the population. Lastly, a simple random sampling technique, specifically using a die, was used to select male and female students from each school.

The researcher developed two instruments for data collection: the Formative Assessment Practice Questionnaire (FAPQ) and the Biology Achievement Test (BAT). The FAPQ consists of two sections: personal data and 25 Likert scale items to evaluate teachers' formative assessment practices. The Test-Taking Skills Questionnaire (TTSQ), similar in structure to the FAPQ, gathers information on students' test-taking skills. The BAT was designed using a test blueprint, focusing on Genetics, Ecology, and Reproductive systems, which are identified as challenging areas in WASSCE reports, and includes 50 multiple-choice items.

Three experts from the Department of Science Education (two from measurement and evaluation and one from biology education) validated the instruments for face validity. The FAPQ's reliability index, obtained using Cronbach's alpha, was 0.72, while the BAT's reliability, obtained using Kuder-Richardson 20, and was 0.82.

Simple linear regression and multiple linear regression analyses were conducted to obtain R and R square values to address the research questions. Hypotheses were tested using the associated t-value, exact

probability value, and moderation analysis values with Andrew Hayes Process Macro, all at a 0.05 alpha level. Correlation coefficients (R) were interpreted as follows: 0.00 to 0.20 as a very low relationship, 0.20 to 0.40 as a low relationship, 0.40 to 0.60 as a medium relationship, 0.60 to 0.80 as a high relationship, and 0.80 to 1.00 as a very high relationship (Nwana, 1979). If the exact probability value was less than the significance level (0.05), the null hypothesis was rejected; otherwise, it was not rejected.

## Results

**Table 1: “Linear regression analysis of the predictive power of Formative assessment practices on secondary school students’ academic achievement in biology**

Model	N	R	R <sup>2</sup>	Adjusted R <sup>2</sup>
1	271	0.77	0.60	0.60

**Note N=Number of Respondents, R=Correlation coefficient, R<sup>2</sup>=Coefficient of determination**

The results in Table 1 demonstrate the predictive power of formative assessment practices on secondary school students' academic achievement in biology. The coefficient of determination was 0.60, indicating that 60% of the variation in students' academic achievement in biology is due to formative assessment practices. This also means that the remaining 40% of the variation is influenced by other

factors. The high R<sup>2</sup> value suggests a strong predictive power of formative assessment practices on students' academic achievement in biology. Additionally, the correlation coefficient (R) between formative assessment practices and students' academic achievement in biology was 0.77, indicating a high positive relationship between the two.

**Table 2: t-test associated with linear regression on the predictive power of Formative assessment practices on secondary school student's academic achievement in biology**

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Dec.
		B	Std. Error	Beta			
1	(Constant)	15.746	2.723		5.783	0.00	S
	FAP	0.754	0.037	0.77	20.178	0.00	S

**α = 0.05 Level of significance, S= Significant, NS= Not Significant**

The result in Table 2 shows the t-test analysis associated with linear regression of the predictive power of formative assessment practices on secondary school student's academic achievement in Biology. The results indicate a significant predictive power of formative assessment practices on secondary school students' academic achievement in biology (t = 20.178, P = 0.00). Since the associated probability is less than

the 0.05 significance level, the null hypothesis, which stated that there is no significant predictive power, is rejected. The inference drawn is that the predictive power of Formative assessment practices on secondary school student's academic achievement in biology is statistically significant. This implies that students' Formative assessment practices can improve academic achievement in biology.



**Table 3: predictive power of formative assessment practices on students’ academic achievement in Biology as moderated by gender**

Model	Gender	N	R	R <sup>2</sup>	SE	t	LLCI	ULCI	P
1	Male	154	.7809	.6098	.0760	2.9852	.0088	.3083	.0380
	Female	117							

**Key: LLCI- lower level of the 95% confidence interval; ULCI- upper level of the 95% confidence interval; R=Correlation coefficient, R<sup>2</sup>=Coefficient of determination, SE- standard error**

The results in Table 3 indicate the predictive power of formative assessment practices on students' academic achievement in biology, moderated by gender. The coefficient of determination ( $R^2=0.61$ ) suggests that 61% of the variation in students' academic achievement in biology, predicted by formative assessment practices, is moderated by gender. The analysis also shows a correlation coefficient (R) of 0.78, indicating a high positive relationship between formative assessment practices and students' academic achievement in biology, as moderated by gender. However, there is no significant predictive power of formative assessment practices on students' academic achievement in biology when moderated by gender. Table 3 also reveals that the t-value for the predictive power of formative assessment practices on students' academic achievement in biology, moderated by gender, is 2.0852 with an associated p-value of .0380. Since this p-value is less than the 0.05 significance level, the null hypothesis is rejected. Therefore, it is inferred that gender significantly moderates the predictive power of formative assessment practices on secondary school students' academic achievement in biology.”

**Discussion**

The results indicate the predictive power of formative assessment practices on secondary school students' academic achievement in biology, with a coefficient of determination of 60%. This means that formative assessment practices account for 60% of the variation in students' academic achievement in biology. Further analysis showed that the probability associated with the calculated t-value was less than the level of significance, leading to the rejection of the null hypothesis. This implies that the predictive power of formative assessment practices on students' academic achievement in biology is statistically significant. This may be because formative assessment practices provide

opportunities for targeted support to students, potentially leading to higher grades. This finding aligns

with the reports of Ozan and Kincal (2018) and Rokos, Zavodska, and Petr (2016), which also found that formative assessment practices significantly impact academic achievement in biology. Thus, the study adds to the empirical evidence that formative assessment practices are a significant predictor of secondary school students' academic achievement in biology.

Additionally, the results show that 61% of the prediction of formative assessment practices on students' academic achievement in biology is moderated by gender. Further analysis revealed that the moderating effect of gender is significant. This implies that the prediction of formative assessment practices on academic achievement in biology differs between male and female students. This may be because, in the north-central part of the country, males are more frequently placed in science classes than females. Teachers may believe that males are better at learning science subjects and thus provide more constructive and ongoing feedback to male students, potentially motivating them to learn biology better and achieve higher grades than their female counterparts. This finding contrasts with Ihenko (2017), who found no significant effect of gender on achievement in science, but aligns with Amedu (2015), who showed that gender significantly influences students' achievement. Therefore, the study adds to the empirical evidence that gender moderates the predictive power of formative assessment practices on secondary school students' academic achievement in biology.

**Conclusion**

The study concludes that formative assessment practices are strong predictors of students' academic achievement in biology. The corresponding hypotheses indicate that formative assessment practices significantly predict students' academic performance in this subject. Additionally, the study concludes that



gender effectively moderates the predictive power of both formative assessment practices and test-taking skills on academic achievement in biology.

### Recommendations

1. Government and school administrators should prioritize the integration of formative assessment practices in educational interventions. This can be achieved by emphasizing ongoing, constructive feedback, setting challenging learning goals and incorporating tasks that require substantial effort among others.
2. Equal participation opportunities in science oriented subjects as well as during formative assessments should be given to both male and female students by class teachers in order to eliminate gender biasness.

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