STEM Education Review

REVIEW ARTICLE

Scaffolding-Enriched Assessment for Students' Emotional Outcomes in Biology: Interaction Effects of Gender on Test Anxiety and Emotional Intelligence

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ABSTRACT

This study examined the interaction effects of scaffolding-enriched assessment and gender on students' test anxiety and emotional intelligence in Biology in Benue State, Nigeria. Two research questions and two hypotheses guided the study. A quasi-experimental, non-randomised pre-test–post-test control-group design with a 3 × 2 factorial structure was adopted. The sample comprised 245 SS II Biology students (153 males, 92 females) selected from six intact classes using multistage sampling. Participants received Scaffolding-Enriched Diagnostic Assessment with Feedback and Remediation (SDAFR), Feedback Only (SDAF), or Scaffolding-Enriched Conventional Assessment (SCTA). Data were collected using the Students' Test Anxiety Questionnaire in Biology and Students' Emotional Intelligence Questionnaire in Biology, with reliability coefficients of 0.88 and 0.92, respectively. The seven-week intervention involved pre-testing, five weeks of treatment and post-testing. Mean and standard deviation answered the research questions, while ANCOVA tested the hypotheses at 0.05 significance level. Results showed no significant interaction effect of assessment technique and gender on test anxiety, $F(2, 238) = 1.325$, $p = .268$, $\eta p^2 = .011$, or emotional intelligence, $F(2, 238) = 2.427$, $p = .090$, $\eta p^2 = .020$. The study concludes that gender did not significantly moderate the effects of scaffolding-enriched assessment on students' emotional wellbeing. Biology teachers should therefore adopt scaffolding-enriched assessment practices equitably for male and female students.

Keywords: Scaffolding-enriched assessment; Test anxiety; Emotional intelligence; Emotional wellbeing; Gender; Biology education and secondary school students

INTRODUCTION

Science education, particularly Biology, is vital to national development because it supports health, agriculture, biotechnology, environmental conservation, employment and economic growth. Biology learning also develops critical thinking, creativity, problem-solving, communication, observation and psychomotor skills (Kpiranyam et al., 2024b, 2024d). Consequently, effective Biology instruction should promote active, hands-on and minds-on learning through constructivist approaches. However, students often struggle with Biology due to the abstract and complex nature of its concepts, inadequate instructional resources, ineffective teaching approaches, learning and assessment anxiety.

Assessment is a systematic process of gathering, analysing and interpreting information about learners to guide educational decisions and improve teaching and learning (Denga, 2016; Udechukwu, 2020). It may involve dia-

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Received: 7 March 2025; Revised: 11 March 2025; Accepted: 1 July 2025
https://doi.org/10.67229/stemer.26080021

gnostic, formative and summative approaches, but effective assessment should be integrated with instruction rather than treated as a separate activity. Contemporary approaches increasingly emphasise feedback, reflection, correction and learner support, including the use of instructional scaffolding during assessment (Double et al., 2020). Although the National Policy on Education emphasises continuous assessment as a means of improving learning (FRN, 2014), evidence suggests that many Biology teachers continue to rely heavily on conventional and summative assessment practices (Omaka & Osuafor, 2020). This creates a need for assessment approaches that not only measure learning but also identify students' difficulties and provide appropriate support.

Diagnostic assessment is designed to identify learners' specific difficulties, weaknesses and misconceptions so that appropriate instructional support can be provided (Pila, 2016; Esomonu & Eleje, 2020). Unlike assessment that merely records performance, diagnostic assessment provides information that can guide targeted intervention and instructional adjustment. It can be strengthened through feedback and remediation. Feedback provides learners with information about their progress and areas requiring further attention, while remediation guides them towards correcting identified deficiencies (Obilor et al., 2020; Ajogbeje & Alonge, 2012). Thus, diagnostic assessment enriched with feedback and remediation can provide learners with targeted support in response to identified difficulties.

Students' emotional wellbeing in educational settings can be considered in terms of their capacity to understand and regulate emotions and their responses to challenging situations. Two constructs particularly relevant to this dimension are emotional intelligence and test anxiety.

The origin of emotional intelligence can be traced to earlier attempts to broaden the understanding of intelligence, including Gardner's multiple intelligence theory in 1983 and the works of Williams and Sternberg in 1988. The term emotional intelligence was coined by Salovey and Mayer in 1990 (Hanior, 2017). Chamundeswari (2013) viewed emotional intelligence as an individual's ability to recognise the meanings of emotions and use them to reason and solve problems. Nnaji et al. (2020) and Iqbal et al. (2022) noted that emotional intelligence involves the ability to perceive emotions, understand emotions, manage emotions and use one's emotions and those of others. Chamundeswari (2013) conceptualised emotional intelligence as comprising self-awareness, self-management, self-motivation, empathy and relationship management.

Studies have examined emotional intelligence in science education (Kolachina, 2014; Tehlan & Dalal, 2018; Nnaji et al. 2020; Kpiranyam et al., 2024b), but limited attention has been given to how assessment approaches may influence students' emotional intelligence in Biology. Existing research has largely considered emotional intelligence in relation to general learning experiences rather than the specific characteristics of assessment. This leaves a gap concerning whether assessment enriched with scaffolding can provide an environment that supports students' emotional development.

Test anxiety represents another important emotional dimension of assessment. It refers to the unpleasant emotional, physical and psychological responses that may arise when students anticipate or experience testing. Chishti and Rana (2021) associated test anxiety with stress, nervousness a Biology test. Test anxiety may manifest through nervousness, restlessness, difficulty concentrating, fear of failure and panic. Students' perceptions of their preparedness and knowledge may also influence their level of anxiety (Durakua, 2017).

Assessment practices can influence students' emotional responses to testing. Evidence indicates that instructional and assessment strategies may affect test anxiety (Ezeahurukwe, 2010; Karadeniz, 2011). Scaffolding-enriched assessment may be particularly relevant because guidance, prompts, feedback and corrective support can reduce uncertainty and provide students with direction when they encounter difficulties. By making assessment more supportive and less threatening, scaffolding may help students manage anxiety associated with testing. Nevertheless, there is limited empirical evidence on the relationship between scaffolding-enriched assessment and test anxiety in Biology, particularly in the study area.

Gender is another variable that may shape students' test anxiety and emotional experiences during assessment in Biology. Learners of Biology may respond differently to assessment situations because of differences in social expectations, Biological classroom experiences and perceptions associated with gender. However, gender should not be assumed to produce uniform differences because its influence may depend on the instructional and assessment conditions within which students operate. Empirical findings have been inconsistent. Karadeniz (2011) reported lower test anxiety among male students, whereas Cotner et al. (2020) found higher test anxiety among female students. Conversely, other studies have reported no significant gender differences in some affective outcomes (Orokpo & Achor, 2016; Nwuba et al., 2024; Kpiranyam et al., 2025). These inconsistencies suggest that gender may interact with instructional and assessment conditions rather than operate as an independent determinant of students' emotional responses.

The interaction between gender and scaffolding-enriched assessment is important because students may respond differently to supportive assessment conditions.

Although growing research has examined scaffolding, test anxiety, emotional intelligence and gender in science education, limited evidence exists on their combined relationship within Biology assessment. In particular, little is known about whether scaffolding-enriched assessment can simultaneously influence test anxiety and emotional intelligence and whether these effects vary by gender. This gap justifies examining the interaction effects of scaffolding-enriched assessment techniques and gender on students' test anxiety and emotional intelligence in Biology.

PROBLEM

Biology education should promote students' emotional wellbeing by supporting their ability to understand, manage and respond appropriately to emotions arising from learning and assessment situations. However, secondary school students in Benue State continue to experience assessment-related challenges, particularly test anxiety, while emotional intelligence receives limited attention in Biology assessment. Persistent test anxiety may interfere with students' concentration, confidence and engagement during assessment, whereas emotional intelligence may support their ability to regulate emotions and cope with challenging assessment experiences. Conventional assessment practices may focus mainly on measuring and grading students' learning, with limited emphasis on diagnosing learning difficulties and providing timely feedback, remediation and supportive guidance that can address both learning and emotional needs. Scaffolding-enriched assessment may provide a viable approach by integrating diagnostic assessment with feedback, remediation and temporary support to help students respond more effectively to assessment demands. Such an approach may reduce uncertainty and anxiety while providing opportunities for students to develop and apply emotional intelligence during challenging learning and assessment situations. However, evidence of the effects of scaffolding-enriched assessment on students' test anxiety and emotional intelligence remains limited, particularly in Biology and among secondary school students in Benue State. Furthermore, the extent to which gender interacts with scaffolding-enriched assessment to influence these emotional outcomes remains insufficiently established. Therefore, this study investigated the interaction effects of scaffolding-enriched assessment and gender on students' test anxiety and emotional intelligence in Biology in Benue State, Nigeria. Specifically, this study:

1. Ascertained the interaction effect of scaffolding-enriched assessment techniques and gender on students' test anxiety in Biology.

2. Determined the interaction effect of scaffolding-enriched assessment techniques and gender on students' emotional intelligence in Biology.

RESEARCH QUESTIONS

The following questions were raised to guide the study:

1.What are the interaction effects of scaffolding-enriched assessment techniques and gender on students' mean test anxiety ratings in Biology?

2.What are the interaction of scaffolding-enriched assessment techniques and gender on students' mean emotional intelligence ratings in Biology?

HYPOTHESES

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

H_1: There are no significant interaction effects of scaffolding-enriched assessmenttechniques and gender on students' mean test anxiety ratings in Biology?

H_2: There are no significant interaction effect of scaffolding-enriched assessmenttechniques and gender on students' mean emotional intelligence ratings in Biology?

METHODOLOGY

The study adopted a quasi-experimental, non-randomised pre-test–post-test control-group design with a 3×2 factorial structure. The design was appropriate because intact classes were used, as schools could not reorganise students or disrupt existing class schedules. The study involved three assessment conditions: Scaffolding-Enriched Diagnostic Assessment with Feedback and Remediation (SDAFR), Scaffolding-Enriched Diagnostic Assessment with Feedback Only (SDAF), and Scaffolding-Enriched Conventional Assessment Technique (SCTA). Gender constituted the second factor, comprising male and female students. The design enabled the study to examine the main and interaction effects of assessment technique and gender on students' test anxiety and emotional intelligence.

POPULATION

The population comprised 19,357 SS II Biology students, consisting of 10,273 males and 9,084 females, in 183 public co-educational senior secondary schools in Benue State during the 2023/2024 academic session (Benue State Teaching Service Board, Makurdi, 2023). SS II students were selected because they had adequate exposure to Biology and relevant school-based assessment experiences.

SAMPLE AND SAMPLING PROCEDURE

A sample of 245 SS II Biology students (153 males and 92 females) from six intact classes was selected using a multistage sampling procedure. First, the state was stratified into three education zones. Second, two Local Government Areas were randomly selected from each zone. Third, one eligible public co-educational senior secondary school was purposively selected from each sampled Local Government Area. Fourth, the six schools were randomly assigned to the three assessment conditions, with two schools per condition. Finally, one intact SS II Biology class was selected from each school. The use of intact classes minimised disruption to normal school activities.

INSTRUMENTATION

Two instruments were used for data collection: the Students' Test Anxiety Questionnaire in Biology (STAQB) and the Students' Emotional Intelligence Questionnaire in Biology (SEIQB). based on relevant literature and the constructs of the study. The STAQB comprised 38 items designed to measure students' test anxiety in Biology. Responses were rated on a four-point scale: Very True (4), True (3), Slightly True (2) and Not True (1). Negatively worded items were reverse-scored, with higher scores indicating higher test anxiety. The SEIQB contained 38 items measuring students' emotional intelligence in Biology. The items addressed students' emotional awareness, regulation, interpersonal relationships and emotional responses in learning situations. The same four-point response scale was used, with negatively worded items reverse-scored. Higher scores indicated higher emotional intelligence.

VALIDATION AND RELIABILITY OF INSTRUMENTS

The STAQB and SEIQB underwent face and content validation by three experts in Biology Education, Educational Psychology, and Measurement and Evaluation. The experts assessed the instruments for clarity, relevance, appropriateness and coverage of the constructs. Their recommendations were incorporated into the final versions. The validated instruments were then trial-tested on 40 SS II Biology students who were not part of the main study. Cronbach's alpha yielded reliability coefficients of 0.88 for STAQB and 0.92 for SEIQB, indicating satisfactory internal consistency.

METHOD OF DATA COLLECTION AND TREATMENT PROCEDURE

Permission was obtained from the principals of the sampled schools. Six qualified Biology teachers served as research assistants and received standardised training on the study procedures. The training included the objectives, assessment techniques, lesson plans, instructional materials and administration of the instruments. Pre-test instruments were administered before the intervention, while the same instruments were administered as post-tests after the intervention. The intervention lasted seven weeks. Week 1 was used for pre-testing, Weeks 2–6 for treatment, and Week 7 for post-testing. All groups received scaffolding-enriched Biology instruction involving prompts, cues, hints, guided worksheets, collaborative activities and classroom participation. The researcher developed 15 lesson plans covering cellular respiration and excretory systems. The plans reflected the principles of SDAFR, SDAF and SCTA and ensured consistency in content, instructional time and learning activities across the three groups. The SDAFR group received diagnostic assessment, targeted feedback and remediation of identified learning difficulties. The SDAF group received diagnostic assessment and feedback but no systematic remediation. The SCTA group received scaffolding-enriched instruction and conventional classroom assessment without diagnostic assessment, targeted feedback or remediation.

ETHICAL CONSIDERATIONS

Ethical standards were observed throughout the study to protect participants' rights and welfare. Approval was obtained from the relevant education authorities and principals of the participating schools. Written informed consent was obtained from parents or guardians, while students provided voluntary assent after the study was explained in age-appropriate language. Participants were informed of their right to withdraw at any time without academic consequences. Confidentiality and anonymity were maintained, and the data collected were used solely for research purposes.

CONTROL OF EXTRANEOUS VARIABLES

Teacher effects were controlled through standardised training and uniform lesson plans. Treatment contamination was minimised by assigning only one assessment condition to each school. Pre-test sensitisation was reduced through a five-week interval between pre- and post-testing. Initial differences among intact classes were controlled statistically using pre-test scores as covariates. Treatment fidelity was maintained through standardised materials and monitoring of implementation.

METHOD OF DATA ANALYSIS

Data were analysed using mean (), standard deviation (SD) to answer the research questions. The hypotheses were tested using Analysis of Covariance (ANCOVA) at

the 0.05 level of significance. The null hypothesis was rejected when the *p*-value was less than 0.05 and not rejected when the *p*-value was greater than or equal to 0.05.

RESULTS

The data analysis and interpretation were done in line with the research questions and hypotheses, and were sequentially presented in respective tables

Research Question 1

What is the interaction effect of scaffolding-enriched assessment techniques and gender on students' mean test anxiety ratings in Biology?

In Figure 1, the interaction pattern shows that the plots for male and female students do not intersect of strategies (SDAFR and SDAF) and gender on students' test anxiety in Biology. However, the intersection pattern for SCTA and gender suggests that there is an interaction effect of SCTA and gender on students' test anxiety in Biology. This indicates that there is no likelihood of an interaction effect between strategies (SDAFR and SDAF) and gender. However, the graph lines for gender intersected around SCTAinteraction effect between SCTA and gender in STAQB.

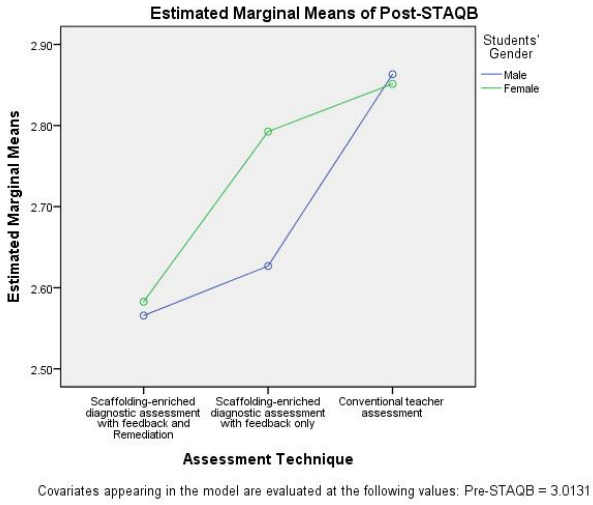

Figure 1. Interaction Effect of Scaffolding-Enriched Assessment Techniques and Gender on the Mean Test Anxiety Ratings of Students in Biology

Hypothesis 1

There are no significant interaction effects of scaffolding-enriched assessment techniques and gender on students' mean test anxiety ratings in Biology.

Table 1 reveals that F(2,238) = 1.325; p = 0.268>0.05. Since the probability level is greater than the specified alpha level of 0.05, the null hypothesis is not rejected. This means that there are no significant interaction effects of scaffolding-enriched assessment techniques and gender on students' mean test anxiety ratings in Biology. The value of 0.011 for techniques and gender implies that 1.1% of the difference in the students' test anxiety ratings can be accounted for by scaffolding-enriched assessment techniques and gender. This indicates a very low effect size.

Research Question 2

What the interaction effect of scaffolding-enriched assessment techniques and gender on students' mean emotional intelligence ratings in Biology?

In Figure 2, the interaction pattern shows that the plots for male and female students do not intersect of assessment techniques (SDAFR and SDAF) and gender on students' emotional intelligence in Biology. However, the intersection pattern for conventional teacher assessment and gender suggests that there is an interaction effect of SCTA and gender on students' test anxiety in Biology. This indicates that there is no likelihood of an interaction effect between techniques (SDAFR and SDAF) and gender. However, the graph lines intersected for gender around SCTAinteraction effect between SCTA and gender in SEIQB.

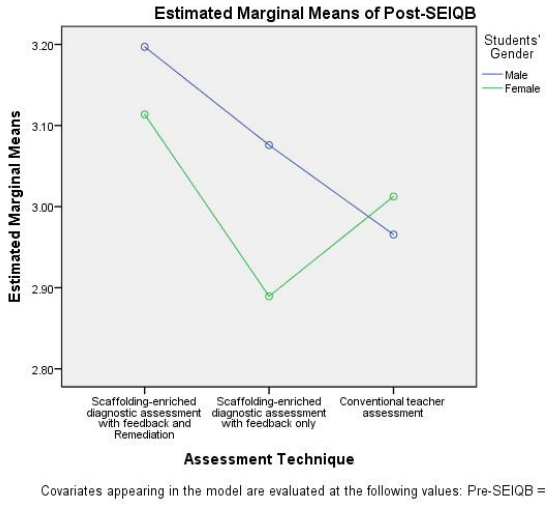

Figure 2. Interaction Effect of Scaffolding-Enriched Assessment Techniques and Gender on the Mean Emotional Intelligence Ratings of Students in Biology

Hypothesis 2

There no significant interaction effect of scaffolding-enriched assessment techniques and gender on students' mean emotional intelligence ratings in Biology.

Table 2 reveals that F(2,238) = 2.427; p = 0.090>0.05. Since the probability level is greater than the specified alpha level of 0.05. Therefore, the null hypothesis is not

Table 1: Summary of ANCOVA for Interaction Effects of scaffolding-enriched assessment techniques and Gender on Students' Test Anxiety Ratings in Biology

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4.728[a]	6	.788	5.789	.000	.127
Intercept	12.681	1	12.681	93.148	.000	.281
Pre-STAQB	1.626	1	1.626	11.941	.001	.048
Techniques	2.711	2	1.355	9.956	.000	.077
Gender	.184	1	.184	1.354	.246	.006
Techniques * Gender	.361	2	.180	1.325	.268	.011
Error	32.400	238	.136			
Total	1835.620	245				
Corrected Total	37.128	244				

Note: a. R Squared = .127 (Adjusted R Squared = .105)

Table 2: Summary of ANCOVA for Interaction Effects of Scaffolding-Enriched Assessment Techniques and Gender on Students' Emotional Intelligence Ratings in Biology

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.297[a]	6	.383	3.505	.002	.081
Intercept	46.139	1	46.139	422.502	.000	.640
Pre-SEIQB	.407	1	.407	3.723	.055	.015
Techniques	1.304	2	.652	5.969	.003	.048
Gender	.306	1	.306	2.805	.095	.012
Techniques * Gender	.530	2	.265	2.427	.090	.020
Error	25.990	238	.109			
Total	2300.390	245				
Corrected Total	28.287	244				

Note: a. R Squared = .081 (Adjusted R Squared = .058)

rejected. This means that no significant interaction effect of scaffolding-enriched assessment techniques and gender on students' mean emotional intelligence ratings in Biology. The value of 0.012 for techniques and gender implies that 1.2% of the difference in the students' emotional intelligence ratings can be accounted for by scaffolding-enriched assessment techniques and gender. This indicates a very low effect size.

DISCUSSION

Findings revealed that the interaction between scaffolding-enriched assessment techniques and gender on students' test anxiety was not significant, $F(2, 238) = 1.325$, $p = .268$, $\eta p^2 = .011$. Although the interaction plot suggested a possible differential pattern under the conventional teacher assessment condition, the pattern was not statistically significant. This finding indicates that male and female students responded similarly to the assessment techniques in terms of test anxiety. The finding agrees with Ezeahurukwe (2010), who reported no significant interaction effect of elaborative interrogation, self-assessment and gender on Mathematics test anxiety. It is also consistent with Nwuba et al. (2024), who found that inquiry-based instruction significantly reduced Biology students' test anxiety irrespective of gender. Similarly, Chukwuorji and Nwonyi (2015) reported that gender did not significantly contribute to test anxiety among Nigerian secondary school students, with self-esteem emerging as a more important predictor.

The finding may be explained by the supportive features of scaffolding-enriched assessment, which provide male and female students with opportunities to identify learning difficulties, receive feedback, correct errors and obtain remediation. These processes can reduce uncertainty about assessment demands and increase students' confidence in dealing with difficult Biology concepts. Thus, the diagnostic, feedback and remediation components may have created a relatively gender-neutral assessment environment in which male and female students experienced comparable reductions in test anxiety. Educationally, the finding suggests that Biology teachers can apply scaffolding-enriched assessment to both genders without assuming that different assessment approaches are required to manage test anxiety. Diagnostic tasks, timely

feedback, remediation and guided support should therefore be provided equitably to help students understand their learning difficulties and approach Biology assessment with greater confidence.

Similarly, findings revealed that the interaction between scaffolding-enriched assessment techniques and gender on students' emotional intelligence was not significant, $F(2, 238) = 2.427$, $p = .090$, $\eta p^2 = .020$. The finding indicates that gender did not significantly alter students' responses to the assessment techniques in terms of emotional intelligence. Although the interaction effect was small, male and female students generally responded similarly across the assessment conditions. The limited evidence on this specific interaction makes direct comparison with previous studies difficult. However, the finding is consistent with Kpiranyam et al. (2025), who found no significant gender difference in emotional intelligence among Biology students exposed to scaffolding-enriched diagnostic assessment.

CONCLUSION

The study concludes that scaffolding-enriched assessment techniques did not have significant interaction effects with gender on students' test anxiety and emotional intelligence in Biology. This indicates that the assessment techniques produced comparable outcomes for male and female students. Educationally, scaffolding-enriched assessment can therefore be applied equitably to both genders, with diagnostic support, feedback and remediation provided according to students' learning needs rather than gender.

RECOMMENDATIONS

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

1. Teachers of Biology should utilize scaffolding-enriched assessment to correct male and female students' errors and misconceptions since this has been established to reduce test anxiety and improve emotional intelligence and performance in Biology.

2. Ministry of Education and school administrators should ensure constant supervision of Biology curriculum implementation and should encourage Biology teachers . This could reduce male and female students' test anxiety and develop emotionally intelligent in Biology.

Since Scaffolding-enriched diagnostic assessment is not gender sensitive, to engage using the approach to diminish students' anxiety during test situations and improve their emotional intelligence and performance in Biology.

DECLARATION

Acknowledgments
We acknowledge all the authors whose works were used in his study. We also acknowledge all he schools principals, teachers and students who were helpful in the course of this study.

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Funding
The authors did not get any support from research funding bodies.

Ethics approval and consent to participate
Not Applicable

Conflict of interest
Not Applicable in this case.

Availability of data
Students' Test Anxiety Questionnaire in Biology and Students' Emotional Intelligence Questionnaire in Biology were first developed after which the instruments were subjected to experts for validation and the instruments were trail tested on 40 Biology SS II students who were not part of the sample selected but had similar characteristics with the main sample selected. The test score were computed to see it reliability. Pretest given the subjects selected followed by treatment which lasted for 7 weeks and post was given for final data collection.

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