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Enhancing Students' Emotional Intelligence in Biology Through Scaffolding-Enriched Diagnostic Assessment in Benue State

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Abstract
The study was an attempt to enhance secondary school students' emotional intelligence in Biology through scaffolding-enriched diagnostic assessment techniques in Benue State. Three questions were answered and three hypotheses tested at 0.05 level of significance. This study utilized a quasi-experimental design characterized by a non-randomized pre-test and post-test control group framework. Population comprised 19,357 Senior Secondary Two (SS II) students, 10,273 males and 9,084 females, enrolled in Biology across 183 public co-educational schools. Sample comprised 245 (153 males and 92 females) students. Students' Emotional Intelligence Questionnaire in Biology (SEIQB) was developed by the researchers and validated by a panel of three experts. It had reliability value of 0.92 determined using Cronbach's Alpha. Three research assistants taught the three groups, Scaffolding-enriched Diagnostic Assessment with Feedback and Remediation (SDAFR) Scaffolding-enriched Diagnostic Assessment with Feedback (SDAF) and Scaffolding-enriched Conventional Assessment (SCTA) and administered the instrument. Data were analyzed using mean and standard deviation (SD) to address the research questions. Analysis of Covariance (ANCOVA) was employed to test the null hypotheses. Bonferroni's post hoc analysis was also used. The results revealed a significant difference in the mean emotional intelligence ratings of Biology students exposed to SDAFR, SDAF, and SCTA ($F(3, 241) = 6.080$, $p = 0.003 < 0.05$). Post hoc bivariate comparisons indicated significant differences ($p < 0.05$) between SDAFR and SDAF, and between SDAFR and SCTA, while no significant difference was observed between SDAF and SCTA ($p > 0.05$). Furthermore, findings showed no significant difference in the mean emotional intelligence ratings between male and female Biology students exposed to SDAFR ($F(2, 72) = 0.916$, $p = 0.342 > 0.05$) or SDAF ($F(2, 88) = 2.778$, $p = 0.099 > 0.05$). Based on these findings, it is recommended, among others that Biology teachers adopt SDAFR to enhance students' emotional intelligence in Biology.

Keywords: Diagnostic Assessment, Scaffolding-Enriched Instruction, Emotional Intelligence, Biology, Students

Introduction

Science education stakeholders continue to canvass for a holistic education which covers cognitive, affective (emotional) and psychomotor dimensions. Such an education may better care for the educational need of students especially those learning Biology. Students studying Biology experience life in its natural form through acquisition of biological knowledge, skills and positive attitude. In accordance with the educational objectives outlined in the National Policy on Education (Federal Republic of Nigeria, FRN, 2014), engaging students in activity-oriented learning could foster emotional stability and effectively nurture their emotional intelligence. Emotional intelligence is a key psychological construct. To address the challenges students encounter in traditional schooling and their subsequent careers, it is essential to cultivate responsible and emotionally healthy science students. Accordingly, a holistic approach to education, encompassing the academic (cognitive), behavioral (action), and affective (emotional) domains, is imperative. Chamundeswari (2013) defines emotional intelligence as an individual's ability to recognize the significance of their emotions and utilize them to reason and solve problems. Similarly, Hashempour and Mehrad (2014) describe emotional intelligence as an intrinsic motivator linked to students' capabilities, which enhances their learning. This motivation drives students to pursue their goals with greater focus and attention to their studies. According to Nnaji et al. (2020), emotional intelligence

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is the ability of students to perceive, understand, and manage their own emotions as well as those of others. The authors argue that emotions can create a conflict between students' perceptions of what they think they know and the actual reality they observe. Emotions integrate both the quality of thinking and feeling. For example, if students believe they are incapable of learning Biology, performing practical activities, or excelling in Biology tests, this mindset can negatively influence their approach to the subject.

Emotionally intelligent students tend to exhibit high levels of confidence, curiosity, intentionality, self-control, relatedness, effective communication, and cooperative abilities. According to Connor (2018), qualities of an emotionally intelligent student include empathy, self-awareness, curiosity, an analytical mind, belief, and an understanding of their needs and desires. Other important traits are passion, optimism, adaptability, and a willingness to help others learn successfully. Emotional intelligence is demonstrated when a student exhibits competencies such as self-awareness, self-management, social awareness, empathic understanding, and strong social skills, especially during Biology lessons or practical activities. Furthermore, emotional intelligence can be enhanced by actively engaging students through learning and assessment methods, particularly using diagnostic assessment techniques. The concept of diagnostic assessment is generally seen by different scholars in different ways. Shettima et al. (2021) describe diagnostic assessment as the process used by teachers to identify students' areas of learning difficulties or challenges in understanding concepts or performing skills and the likely causes. Esomonu and Eleje (2020) assert that diagnostic assessment is often administered prior to teaching and learning or during the teaching when the need arises. Diagnostic assessment is employed when a student continues to face learning difficulties that may negatively impact their emotional intelligence, despite prior intervention efforts. In the context of Biology, such assessment enables the teacher to diagnose and identify specific areas where students struggle. As Esomonu and Eleje (2020) note, it helps pinpoint the exact concept or area in which a student makes consistent errors. According to Ofem et al. (2017), the primary objective of diagnostic assessment is to uncover areas of conceptual misunderstanding, which may contribute to reduced emotional intelligence. These difficulties can be identified on an individual basis or across groups of students, and can be analyzed for each concept or set of questions. Vogt et al. (2020) outline four key principles that guide effective diagnostic assessment: sharing learning goals, strategic questioning, self/peer assessment, and constructive feedback. In a scaffolding-enriched diagnostic assessment approach, the teacher administers a diagnostic test at the start of a lesson, provides timely feedback, and engages students in scaffolded instruction. This process supports learners in recognizing their misconceptions and correcting them, thereby potentially improving both their conceptual understanding and emotional intelligence in Biology.

A critical question that arises is whether diagnostic assessment**,** which offers a detailed analysis of students' strengths and weaknesses during Biology instruction, can also enhance their emotional intelligence**.** Currently, there is limited research on the impact of such assessments on students' emotional intelligence in science education, particularly in Biology. Abani et al. (2021) reported a high level of utilization of cognitive diagnostic assessment among teachers in Maiduguri Metropolis, Borno State. However, existing literature reveals a significant gap, as most studies have focused on the effects of diagnostic assessment on students' academic performance in Mathematics (Ofem, Idika, & Ovat, 2017) and the social sciences (Esomonu & Eleje, 2020), with little attention given to its influence on emotional intelligence in the sciences. Studies have been conducted on emotional intelligence in science in different locations of the world (Pool & Qualter, 2012; Kolachina, 2014; Umar, 2015; Mei-Shiu, 2016; Orokpo & Achor, 2016; Tehlan & Dalal, 2018; Nnaji et al., 2020; Simonsmeier et at., 2020; Prakash & Vasimalairaja, 2021; Keller et al., 2023; Kpiranyam et al., 2024). However, to the best of the researcher's knowledge, studies examining the effect of diagnostic assessment techniques on students' emotional intelligence in science, particularly in Biology, remain scarce. Such related studies mentioned above were conducted in other aspects of science education than assessment. Nnaji et al. (2020) emphasized the need for further research in the field of emotional intelligence to address and clarify unresolved issues. Several researchers, however, have focused more on the relationship between emotional intelligence and academic performance (Kolachina, 2014; Tehlan & Dalal, 2018; Babajide & Amosu, 2019; Waiswa et al., 2020; Prakash & Vasimalairaja, 2021) and test anxiety (Bayani, 2015) but have neglected the area of assessment. Hence, the need for this study. This study was an attempt to find out if secondary school students' emotional intelligence in Biology can be enhanced through scaffolding-enriched diagnostic assessment techniques using in Benue State.

Research Questions

To guide the direction of the study, the following research questions were posed:

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1. What is the difference in the mean emotional intelligence ratings of students in Biology when exposed to scaffolding-enriched diagnostic assessment with feedback and remediation, scaffolding-enriched diagnostic assessment with feedback only and scaffolding-enriched conventional teacher assessment?
2. What are the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback and remediation?
3. What are the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback only?

Hypotheses

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

H_o1: There is no significant difference in the mean emotional intelligence ratings of students in Biology when exposed to scaffolding-enriched diagnostic assessment with feedback and remediation, scaffolding-enriched diagnostic assessment with feedback only and scaffolding-enriched conventional assessment.

H_o2: There is no significant difference between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback and remediation.

H_o3: There is no significant difference between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback only.

Materials and Methods

This study employed a quasi-experimental design**,** specifically the non-randomised pre-test, post-test control group type**.** This design was chosen because the participating schools did not permit disruption of their schedules or the reorganization of classes for research purposes. As a result, intact classes from the selected schools were used. The design was deemed appropriate, as it is considered one of the most valid approaches for identifying causal relationships when working with intact groups (Emaikwu, 2015; Agogo & Achor, 2019). The study was carried out in Benue State, Nigeria. The population for this study comprised 19,357 Senior Secondary Two (SS II) students (10,273 males and 9,084 females) offering Biology in 183 public co-educational senior secondary schools in Benue State during the 2023/2024 academic session (Benue State Teaching Service Board, Makurdi, 2023). A sample of 245 SS II students (153 males and 92 females) offering Biology was drawn from six intact classes **i**n public co-educational senior secondary schools in Benue State, using a multi-stage sampling procedure involving stratified, purposive and simple random sampling to select intact classes. **T**he Students Emotional Intelligence Questionnaire in Biology (SEIQB) was developed by the researchers after search of literature. The instrument consisted of two sections, A and B**.** Section A collected demographic information, specifically the respondents' gender**.** Section B measures had 38 items and emotional intelligence construct (issues of students' relationship with others, emotional security, classroom activeness, intimacy, acceptance, dependability, emotional reliance, warmth and relatedness). The response mode was Very True (VT) 4 points, True (T) 3 points, Slightly True (ST) 2 points and Not True (NT) 1 point for positively skewed items. Items framed in negative form were scored in reverse order. Respondents were instructed to indicate their level of agreement or disagreement by ticking (√) the items that best applied to them. The aggregate mean ratings were analysed to ascertain the effectiveness of the assessment techniques on students' emotional intelligence in Biology. To establish the validity of the instrument, the SEIQB was subjected to face validity assessment. It was reviewed by three experts: one in Biology Education from Joseph Sarwuan Tarka University, Makurdi; one in Educational Psychology from the Department of Educational Foundations; and one in Measurement and Evaluation from the Department of Science and Mathematics Education, both at Benue State University, Makurdi. The experts identified a punctuation error in item 1 and recommended restructuring for items 7 and 28. All comments, suggestions, and corrections provided by the evaluators were incorporated to enhance the instrument's overall quality. The validated instrument was pilot tested on 40 SS II Biology students from an intact class in a public co-educational senior secondary school within the study area, who were not included in the main study sample. The instrument was administered by a regular Biology teacher in the school under the supervision of the researcher. One day was used to administer the instrument. The reliability of SEIQB computed using Cronbach's Alpha method was 0.92. Thus, the instrument is considered reliable as 0.7 and above is adequate (Emaikwu (2015). The researcher visited six sampled schools and obtained permission from principals of the schools. Six Biology teachers from the sampled schools who are B.Ed or BSc. (Ed) Biology graduates and have taught for at least five years were used as research assistants for this study. Research assistants received training on how to implement the experimental procedures prior to the commencement of the study. The study was carried out over seven weeks during the third term of the 2023/2024 academic session. In the first week, the SEIQB was administered as a pre-test to all participating groups. Instruction began in the second week and continued for five weeks, with each teaching session lasting 80 minutes (a double lesson) per week. A total of three groups were involved in the study. All the groups were taught using

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scaffolding-enriched instruction. In the scaffolding-enriched diagnostic assessment with feedback and remediation (SDAFR) group, the sequence of the lesson was as follows: assessment of previous knowledge, introduction (diagnostic test and statement of lesson objectives), presentation (teacher and students' activities with use of instructional materials, peer and self-assessment), whole class discussions, evaluation, and conclusion/assignment. For the scaffolding-enriched diagnostic assessment with feedback only (SDAF), the sequence of the lesson was as follows: assessment of previous knowledge, introduction (diagnostic test and statement of lesson objectives), presentation (teacher and students' activities with use of instructional materials, peer and self-assessment), evaluation, and conclusion/assignment. The scaffolding-enriched conventional teacher assessment (SCTA) group did not benefit from diagnostic assessment, feedback and remediation. The SEIQB was administered in the seventh week during post-test. To address the research questions, mean ($\bar{x}$) and standard deviation (SD) were used, while Analysis of Covariance (ANCOVA) was employed to test the null hypotheses at a 0.05 level of significance. The use of intact classes without prior determination of ability equivalence justified the application of ANCOVA to control for any significant pre-test differences among the groups, a method supported by Agogo and Achor (2019). The decision rule stipulated that null hypotheses would be rejected if the p-value was $p \leq 0.05$**,** and not rejected otherwise. Additionally, where null hypotheses were rejected, Bonferroni's post hoc analysis was conducted for hypothesis one to identify the specific sources of significant differences.

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 difference in the mean emotional intelligence ratings of students in Biology when exposed to scaffolding-enriched diagnostic assessment with feedback and remediation, scaffolding-enriched diagnostic assessment with feedback only and scaffolding-enriched conventional teacher assessment?

Table 1: *Mean and Standard Deviation of Emotional Intelligence Ratings of Students Taught Biology Using SDAFR, SDAF and SCTA*

Group		Pre-SEIQB		Post-SEIQB		Mean Gain
	n	$\bar{x}$	SD	$\bar{x}$	SD	Within Groups
SDAFR	**75**	2.31	0.46	3.15	0.35	**0.84**
SDAF	**91**	2.48	0.36	3.00	0.33	**0.52**
Mean/SD Difference Between Groups		**0.17**	**0.10**	**0.15**	**0.02**	**0.32**
SDAF	**91**	2.48	0.36	3.00	0.33	**0.52**
SCTA	**79**	2.61	0.39	2.99	0.33	**0.38**
Mean/SD Difference Between Groups		**0.13**	**0.03**	**0.01**	**0.00**	**0.14**
SDAFR	**75**	2.31	0.46	3.15	0.35	**0.84**
SCTA	**79**	2.61	0.39	2.99	0.33	**0.38**
Mean/SD Difference Between Groups		**0.30**	**0.07**	**0.16**	**0.02**	**0.46**

Table 1 reveals that the mean gain difference in emotional intelligence ratings between students taught Biology using SDAFR and SDAF was 0.32 in favour of SDAFR. By implication, students taught Biology using SDAFR had higher emotional intelligence than those taught using SDAF. Students in the SDAF group had a lower standard

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deviation value of 0.33 at the Post-SEIQB compared to 0.35 recorded by those in the SDAFR group with between group difference of 0.02. This shows that emotional intelligence ratings of students in the SDAF group are closely clustered to the mean and slightly more consistent than those of the SDAFR group. In addition, the mean gain difference between students taught using SDAF and SCTA was 0.14 in favour of SDAF. This means that students exposed to SDAF had higher emotional intelligence than those exposed to SCTA. The standard deviation value of 0.33 at the Post-SEIQB for students in the SDAF group is similar to that for students in SCTA group. This implies that the emotional intelligence ratings of students in both groups are slightly consistent and less diverse with very few outliers. Also, Table 1 shows that the mean gain difference between students exposed to SDAFR and SCTA was 0.46 in favour of SDAFR. This signifies that students taught Biology using SDAFR had higher emotional intelligence than those taught using SDAF and SCTA. Meanwhile, students taught using SDAF had slightly higher emotional intelligence than those taught using SCTA. The standard deviation value of 0.33 at the Post-SEIQB for students in the SCTA group is lower compared to 0.35 obtained for those in SDAFR group with a difference of 0.02. This means that the emotional intelligence ratings of students in SCTA group are homogenous and slightly less diverse compared to those of SDAFR group.

Research Question 2: What is the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback and remediation?

Table 2: *Mean and Standard Deviation of Emotional Intelligence Ratings of Students Taught Biology Using SDAFR*

Group		Pre- SEIQB		Post- SEIQB		Mean Gain
	n	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$
Male	46	2.33	0.50	3.18	0.37	**0.85**
Female	29	2.27	0.40	3.09	0.30	**0.82**
Mean/SD Difference		**0.06**	**0.10**	**0.09**	**0.07**	**0.03**

Table 2 reveals the Pre-SEIQB and Post-SEIQB of male students taught Biology using SDAFR as 2.33 and 3.18 with 0.50 and 0.37 as their standard deviations respectively. The Pre-SEIQB and Post-SEIQB of female students taught Biology using SDAFR is 2.27 and 3.09 with 0.40 and 0.30 as their standard deviations respectively. Table 2 further shows that male students taught Biology using SDAFR have mean gain of 0.85 while female students had mean gain of 0.82 in the SEIQB. The difference between the mean gain ratings of the two groups is 0.03 in favour of male students. This shows that male students taught Biology using SDAFR developed better emotional intelligence compared to female students. Female students have lower standard deviation value of 0.30 at the Post-SEIQB while male students have 0.37 with between group difference of 0.07. By implication, emotional intelligence ratings of female students are more clustered to the mean, while ratings of male students are a little spread out but not extreme.

Research Question 3: What are the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback only?

Table 3: *Mean and Standard Deviation of Emotional Intelligence Ratings of Students Taught Biology Using SDAF*

Group		Pre-SEIQB		Post-SEIQB		Mean Gain
	n	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$
Male	55	2.37	0.35	3.07	0.34	**0.70**
Female	36	2.65	0.32	2.91	0.29	**0.26**
Mean/SD Difference		**0.28**	**0.03**	**0.16**	**0.05**	**0.44**

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Table 3 reveals the pre-SEIQB and post-SEIQB of male students taught Biology using SDAF as 2.37 and 3.07 with standard deviations of 0.35 and 0.34 respectively. The pre-SEIQB and post-SEIQB of female students taught Biology using SDAF is 2.65 and 2.91 with standard deviations of 0.32 and 0.29 respectively. Table 3 further shows that male students taught Biology using SDAF have mean gain of 0.70 while female students have 0.26. The mean gain difference between the groups is 0.44 in favour of male students. This shows that male students taught Biology using SDAF developed better emotional intelligence compared to female students. The table also shows that female students have lower standard deviation value of 0.29 at the Post-SEIQB while male students recorded 0.34 with between group difference of 0.05. This means that emotional intelligence ratings of female students have few outliers while for male students, they are spread out but not extreme.

Hypothesis 1: There is no significant difference among the mean emotional intelligence ratings of students in Biology when exposed to scaffolding-enriched diagnostic assessment with feedback and remediation, scaffolding-enriched diagnostic assessment with feedback only and scaffolding-enriched conventional teacher assessment.

Table 4: *ANCOVA Results of Emotional Intelligence Ratings of Students Taught Biology using SDAFR, SDAF and SCTA*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.400[a]	3	.467	4.183	.007	.049
Intercept	51.736	1	51.736	463.730	.000	.658
Pre-SEIQB	.258	1	.258	2.313	.130	.010
Techniques	1.357	2	.678	6.080	.003	.048
Error	26.887	241	.112			
Total	2300.390	245				
Corrected Total	28.287	244				

Table 4 indicates that $F(3,241) = 6.080$; $p = 0.003 < 0.05$. Since the probability level is less than the specified alpha level of 0.05, the null hypothesis is rejected. By implication, there is significant difference among the mean emotional intelligence ratings of students in Biology when exposed to scaffolding-enriched diagnostic assessment with feedback and remediation, scaffolding-enriched diagnostic assessment with feedback only and scaffolding-enriched conventional teacher assessment. The R squared value of 0.048 for techniques implies that 4.8% of the difference in the students' emotional intelligence ratings can be accounted for by the scaffolding-enriched assessment techniques. This indicated a small effect size.

Table 5: *Bonferroni Post Hoc test Results of Emotional Intelligence Ratings of Students Taught Biology using SDAFR, SDAF and SCTA*

(I) Assessment Technique	(J) Assessment Technique	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
SDAFR	SDAF	.159*	.053	.009	.031	.286
	SCTA	.176*	.056	.006	.041	.312
SDAF	SCTA	.017	.052	1.000	-.107	.142

Table 5 shows that the bivariate comparison of the techniques of assessing Biology and their effects on the mean emotional intelligence ratings of students (I-J) between SDAFR and SDAF is 0.009 and is significant at $p<0.05$. Also, the mean differences (I-J) between SDAFR and SCTA is 0.006 and is significant at $p<0.05$. However, the mean difference (I-J) between SDAF and SCTA is 1.000 and is not significant ($p>0.05$). This connotes that there are significant differences in the mean emotional intelligence ratings between the students taught Biology using SDAFR and SDAF and those taught using SDAFR and SCTA. However, there is no significant difference in the mean emotional intelligence ratings between students taught Biology using SDAF and SCTA.

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Hypothesis 2: There is no significant difference between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback and remediation.

Table 6: *ANCOVA Results of Emotional Intelligence Ratings of Male and Female Students Taught Biology using SDAFR*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.822[a]	2	.411	3.580	.033	.090
Intercept	20.302	1	20.302	176.854	.000	.711
Pre-SEIQB	.679	1	.679	5.919	.017	.076
Gender	.105	1	.105	.916	.342	.013
Error	8.265	72	.115			
Total	752.330	75				
Corrected Total	9.087	74				

Table 6 indicates that F(2,72) = 0.916; p = 0.342 >0.05. Since the probability level is more than the specified alpha level of 0.05, the null hypothesis is not rejected. By implication, there is no significant difference between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback and remediation. The R-squared value of 0.013 for gender implies that 1.3% of the difference in the students' emotional intelligence ratings can be accounted for by the influence of gender. This indicated a low effect size.

Hypothesis 3: There is no significant difference between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback only.

Table 7: *ANCOVA Results of Emotional Intelligence Ratings of Male and Female Students Taught Biology using SDAF*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.681[a]	2	.341	3.336	.040	.070
Intercept	17.079	1	17.079	167.230	.000	.655
Pre-SEIQB	.144	1	.144	1.413	.238	.016
Gender	.284	1	.284	2.778	.099	.031
Error	8.988	88	.102			
Total	830.470	91				
Corrected Total	9.669	90				

Table 7 shows that F(2,88) = 2.778; p = 0. 099>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 is no significant effect of scaffolding-enriched diagnostic assessment with feedback only on male and female students' mean emotional intelligence ratings in Biology. The R-squared value of 0.031 for gender means that 3.1% of the difference in the students' emotional intelligence ratings can be accounted for by the influence of gender in the Biology class. This indicates a low effect size.

Discussion

Finding revealed that significant difference exists among the mean emotional intelligence ratings of students in Biology when exposed to scaffolding-enriched diagnostic assessment with feedback and remediation, scaffolding-enriched diagnostic assessment with feedback only and scaffolding-enriched conventional assessment. Post Hoc test showed significant differences in the mean emotional intelligence ratings between students taught Biology using SDAFR and SDAF and those taught using SDAFR and SCTA. However, no significant difference was found in the mean emotional intelligence ratings between students taught Biology using SDAF and SCTA. Finding is consistent with that of Pool and Qualter (2012) who found that utilizing teacher interventions can improve

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students' emotional intelligence. This finding also agrees with that of Umar (2015) who reported that visual, audio and kinesthetic learning style significantly improved emotional intelligence in Biology. Similar to this finding, Simonsmeier et al. (2020) reported significant improvements in self-concept of students over time with peer feedback compared to no feedback. The consistency of these findings provide empirical evidence on the superiority of SDAFR and SDAF in improving students' emotional intelligence in Biology. This result could be attributed to the interactive, student-oriented and activity based nature of SDAFR and SDAF. These techniques enabled students to engage in activities, manage their emotions, cooperate with others, apply social skills, become more confidence when expressing emotions and understanding of Biology concepts thus could have stimulated development of high emotional intelligence. This finding is not in agreement with that of Mei-Shiu (2016) who found that teacher assessment significantly improved students' self-concept. The contradiction may be as a result of study design or sample as the study by Mei-Shiu (2016) was a longitudinal study involving children.

Finding revealed that no significant difference exists between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback and remediation. This finding supports that of Orokpo and Achor (2016) who found no significant difference in the motivation scores of male and female students learning Biology. There is scarcity of studies on comparison on effect of scaffolding-enriched diagnostic assessment with feedback and remediation on students' emotional intelligence in Biology subject based on gender. The likely explanation for the outcome in this study may be due to the fact that SDAFR can enable male and female students to interact, make sense of what they learn, cooperate, exchange information between teacher-students and students and their peers. This could enhance their emotional intelligence in Biology.

Findings revealed that there is no significant difference between the mean emotional intelligence ratings of male and female students in Biology exposed to scaffolding-enriched diagnostic assessment with feedback only. This finding coincides with that of Orokpo and Achor (2016) who found no significant difference in the motivation scores of male and female students learning Biology. The finding also supports that of Keller et al. (2023) found no significant difference in self-concept based on gender with the use of peer assessment. There is scarcity of studies on comparison on effect of scaffolding-enriched diagnostic assessment with feedback only on students' emotional intelligence in Biology subject based on gender. However, the likely explanation for the outcome in this study may be due to the fact that SDAF can enable male and female students to interact, make sense of what they learn, cooperate, exchange information between teacher-students and students and their peers. This could enhance their emotional intelligence in Biology.

Conclusion

Based on the findings of the study, it was revealed that secondary school students' emotional intelligence in Biology was enhanced through scaffolding-enriched diagnostic assessment technique with feedback and remediation than with the use of scaffolding-enriched diagnostic assessment technique with feedback only and scaffolding-enriched conventional assessment. With adoption of scaffolding-enriched diagnostic assessment with feedback and remediation in Biology, gender differences in students' emotional intelligence were negligible enhancing science education particularly gender equality in science.

Recommendations

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

1. Biology teachers should utilize scaffolding-enriched diagnostic assessment with feedback and remediation to correct students' errors and misconceptions thereby enhancing their understanding of Biology concepts and improve their emotional intelligence in Biology.
2. Faculties of education in the universities and Colleges of Educations should organise seminars and workshops to enlighten Biology teachers on SDAFR technique so as to enhance effective teaching of Biology at the secondary school level and enhance students' emotional intelligence.

References

Abani, F. S., Jidda G. A., & Gazali, H. B. (2021). Utilization of Cognitive Diagnostic Assessment (CDA) as a feedback tool by secondary school teachers in Maiduguri Metropolis, Borno State. *Kashere Journal of Education, 2(*2), 171-178.

Agogo, P.O., & Achor, E.E. (2019). *Research methods and statistics for beginners.* Optimism Publishers.

Babajide, V.F.T., & Amosu, J. A. M. (2019). The influence of emotional intelligence on academic achievement of senior secondary school students in physics in educational District IV of Lagos State, Nigeria. *Education & Science Journal of Policy Review and Curriculum Development, 9*(2), 196-206.

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Bayani, A.A. (2015). Emotional intelligence as predictor of test anxiety in secondary education students. *European Online Journal of Natural and Social Sciences, 4*(1), 1-7.

Benue State Teaching Service Board, Makurdi (2023). Records and Statistics of secondary schools in Benue State. Records and Statistics Unit, Makurdi.

Chamundeswari, S. (2013). Emotional intelligence and academic achievement among students at the higher secondary level. *International Journal of Academic Research in Economics and Management Sciences, 2*(4), 178-187.

Connor, C.D. (2018). The 10 qualities of an emotionally intelligent person. Retrieved 23th April, 2024 from https://medium.com/personal-growth/the-10-qualities-of-an- emotionally-intelligent-person-f595440af4fb

Emaikwu, S. O. (2015). *Fundamentals of research methodology and statistics*. Selfers Academy Press

Esomonu, N. P. E., & Eleje, J.N. (2020). Effect of diagnostic testing on students' achievement in secondary school quantitative economics. *World Journal of Education, 10*(3), 178-187.

Federal Republic of Nigeria, (2014). *National policy on education.* National Educational Research and Development Council Press.

Hashempour, S., & Mehrad, A. (2014). The effect of anxiety and emotional intelligence on students' learning process. *Journal of Education & Social Policy, 1*(2), 115-122.

Keller, T., Kim, J., & Elwert, F. (2023). Peer effects on academic self-concept: a large randomized field experiment. *European Sociological Review, 39*, 759–774.

Kolachina, A. (2014). Impact of emotional intelligence on academic achievements of expatriate college students in Dubai. *International Journal of Social Science and Humanities Research, 2*(2), 97-103.

Kpiranyam, F.S., Achor, E.E., & Fakaa, S.G. (2024). Scaling up emotional intelligence and critical thinking of students in biology using concept mapping strategies. *Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education, 5*(4), 92- 101.

Mei-Shiu, C. (2016). Effects of teacher assessment and cognitive ability on self-concepts: Longitudinal mechanisms for children from diverse backgrounds. *Saudi Journal of Engineering and Technology,* 1(4), 180-189.

Nnaji, A.D., Eze, F.B., & Madu, B.C. (2020). Assessment of emotional intelligence and its relationship with students' achievement in mathematics. *International Journal of Mathematics and Statistics Studies, 8*(2), 14-25.

Ofem, U.J., Idika, D., & Ovat, S.V. (2017). Effect of diagnostic and feedback assessment approaches in enhancing achievement in Mathematics among secondary school students in Calabar Municipality. *International Journal of Scientific Research in Education, 10*(2), 221-227.

Orokpo, A., & Achor, E.E. (2016). Improving students' motivation through textbook illustration with feedback in learning of Biology in Makurdi Local Government Area. *Benue State University Journal of Education, 16*(1), 59-65.

Pool, L.D., & Qualter, P. (2012). Improving emotional intelligence and emotional self-efficacy through a teaching intervention for university students. *Learning and Individual Differences, 22*(3), 306-312.

Prakash, M. J., & Vasimalairaja, M. (2021). Influence of emotional intelligence and lateral thinking on achievement in biology of XI standard students. *XIlkogretim Online - Elementary Education Online, 20*(5), 2426-2432.

Shettima, F. S., Jidda, A. G., & Gazali, H. B. (2021). Utilization of cognitive diagnostic assessment (CDA) as a feedback tool by secondary school teachers in Maiduguri Metropolis, Borno State. *Kashere Journal of Education, 2*(2), 171-178.

Simonsmeier, B.A., Peiffer, H., Flaig, M., & Schneider, M. (2020). Peer feedback improves students' academic self-concept in higher education. *Research in Higher Education, 61*, 706–724.

Tehlan, I.B., & Dalal, M. (2018). A study of relationship between emotional intelligence and academic achievement of secondary school students. *International Journal of Advanced Research in Management and Social Sciences, 7*(3), 14-24.

Umar, A.Y. (2015). *Effects of visual, audio, kinesthetic learning on emotional intelligence, attitude and performance in ecology among colleges of education students, North-West, Nigeria.* Unpublished Thesis, Ahmadu Bello University, Zaria, Nigeria.

Vogt, K., Tsagari, D., Csépes, I, Green, A., & Sifakis, N. (2020). Linking learners' perspectives on language assessment practices to teachers' assessment literacy enhancement (TALE): Insights from four European countries. *Language Assessment Quarterly, 17*(4), 410-433.

Waiswa, H. C.A., Baguma, P.K., & Oonyu, J. (2020). Emotional intelligence and academic achievement among university upgrading (grade v) teacher students. *African Journal of Education and Practice, 6*(3), 39 – 64.