Probing secondary school students' test anxiety in biology using inquiry-based instructional approach in Anambra State

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ABSTRACT

The study investigated the effect of inquiry-based instructional approach (IBIA) on secondary school students' test anxiety in biology. The study is a quasi-experimental research, adopting specifically the non-randomized control group design. 4,755 (2,067 males and 2,688 females) Senior Secondary year two (SS2) students offering biology in the 62 government owned secondary schools, in Awka Education Zone of Anambra State, Nigeria constituted the population. 52 (20 males and 32 females) SS2 biology students drawn from, two intact classes, in the two sampled schools, using multi-stage sampling procedure constituted the sample size. The instrument for data collection was an adapted Biology Test Anxiety Scale (BTAS), validated by three experts with reliability coefficient of 0.78 established using Cronbach Alpha. In analyzing the collected data, mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was employed to test the null hypotheses. The findings revealed that students taught biology with IBIA significantly showed low test anxiety in biology than those taught with the conventional lecture method, irrespective of gender. Based on the findings, the study concluded that IBIA is a gender friendly, activity-based approach that boosts students' confidence, and promotes meaningful learning in biology. In light of this, it was recommended among others that IBIA should be adopted by biology teachers in secondary schools to actively engage students in the learning process which will in return help boost their confidence during tests and thus, reduce their anxiety.

Keywords: test anxiety; biology; inquiry-based instructional approach; gender

1. INTRODUCTION

Biology, one of the science subjects taught in Nigerian secondary schools, has been recognized as a tool for modern day scientific advancements. Karthik (2022) defined biology as the study of living organisms, their origins, anatomy, morphology, physiology, behaviour, and distribution. It is a branch of natural sciences that focuses on living organisms, their life styles and relationships with each other (Nwuba et al., 2023a). Hence, Biology may simply be defined as a branch of science that studies living things, their forms and their interactions with their environment.

As a subject, the importance of biology to man cannot be overemphasized as it deals with all the physiochemical aspects of life. Supporting the premise, Kareem (2018), in his study, posited that a sound knowledge of biology leads to self-understanding on how the body works as it equips its' learners with knowledge and skills that can help them face challenges in society especially those related to common diseases, pollution, and genetics. Similarly, Nwuba, et al. (2022) stressed that biology provides the knowledge applied in every sphere of life today, ranging from food production, environmental protection, conservation of resources, bioengineering to agriculture with the aim to create a better environment for one to live in. In light of these advantages, one can categorically assert that the impact of the subject on

man and his environment cannot be ignored as it fosters man's understanding of his body system and the environment. Considering these benefits of biology and the subject's nature of little or no mathematical calculations, Nwuba and Osuafor (2021) asserted that students' view the subject as easy and as a result has the highest enrollment in external examinations when compared to other science subjects such as physics and chemistry.

Despite this stereotyped view, of the subject being easy, students' performance in the subject in external examinations, such as WAEC and NECO, has remained unsatisfactory as seen in the West African Examinations Council (WAEC) statistics reports for biology from 2017-2021. That is, for 2017, for aggregate of A_1-C_6, a percentage pass of 55.57 was recorded, 55.10% in 2018, 55.63% in 2019, 63.23% in 2020 and 58.09% in 2021. Researchers (Attamah & Okoli, 2021; Nwosu & Samuel, 2023; Nwuba et al., 2023b) have attributed this unsatisfactory performance of students in biology to many factors that interacts and influences the teaching and learning process, ranging from environmental variables like teacher-related factors, teaching methods and strategies, unconducive learning environment, non-availability of instructional materials for teaching, absence of equipped biology laboratories in schools, inadequate science equipment for practical lessons, high student-teacher ratio (large class size), cumbersome nature of the secondary school biology curriculum to students personal (psychological) variables such as, but not limited to, self-efficacy, reading habits, locus of control, interest, creativity, communication skills, critical thinking, motivation and test anxiety.

Test anxiety is a psychological trait that results from fear of any form of examination. Bada and Idoko (2021) defined it as the psychological state of a candidate, shown by the level of worry, fear, uncertainty, concern and helplessness expressed before, during or after a test. It is a combination of perceived physiological over-arousal, feeling of worry and dread, self-deprecating thoughts, tension and somatic symptoms that occur during test situation of students (Okotcha et al., 2015). Hence, test anxiety is simply fear of examinations by students' usually expressed with symptoms of worry, tension and nervousness. As an innate trait, test anxiety has been reported by many to influence students' academic achievement in schools. Hoffses (2020) asserted that it is one of the major problems among students as well as the biggest hurdles in achieving good grades in science subjects. Supporting the premise, Goswami (2021) identified test anxiety as a major factor contributing to variety of negative outcomes including psychological distress, academic underachievement, academic failure and insecurity.

Students test anxiety in examinations, as reported by many researchers, is influenced by many factors. Loma (2022), in his study, posited that test anxiety can be caused by various reasons among students and these include students: being afraid that they won't live up to the expectations of important people in their life, worrying they will lose the affection of people they care about if they fail, believing that grades are an estimation of their personal worth, placing too much emphasis on a single test, inadequate preparation for tests, and belief that they have no control over their performance or grades. Similarly, Malcom (2021) opined that test anxiety of students is caused by negative past experiences of exams, lack of adequate preparation, poor knowledge of exam-taking techniques or study methods by students, unhelpful thinking about the exam situation or exam outcome, excessive pressure to achieve or perfectionism and students fear of failure. In the same vein, Hyseni-Duraku (2014) pointed out that one major factor that influence test anxiety of students is students' perception regarding the knowledge they have and their inability to enhance their learning. In this light, the study sought to find out if using inquiry based instructional approach in the classroom will boost students' confidence, engage them actively in the learning process and foster meaningful learning, which in return may help reduce their test anxiety in biology and consequently improve their academic achievement in the long run.

Inquiry-based instructional approach (IBIA) is a learning approach that involves learning by discovery. Johnson (2013) defined IBIA as a student-centered method in which students discover things in their environment, develop strong arguments about the natural and physical world around them based on strong justifications, and constructing new knowledge. It is a teaching process that comprises the methods followed by scientists when doing their studies (Kinyota, 2020). In this context therefore, IBIA refers to an activity engaged pedagogical method in which students' discover knowledge of certain phenomena on their own under the guidance of a teacher.

In inquiry-based instructional approach, teachers act as facilitators, and not providers, while students construct knowledge rather than being receivers. Ike (2016) stressed that IBIA through different approaches such as small-group discussion, experiential and cooperative learning encourages students to explore materials, ask questions, and share ideas instead of memorizing facts and materials as they learn, fostering acquisition of knowledge through exploration, experience, and discussion. IBIA often creates a hands-on minds-on learning environment that allows students to connect what they are learning in the classroom to the real world fostering students' 21st century skills like collaboration, communication, critical thinking, problem-solving, and creativity (Wabuke et al., 2017). Summarizing, Issaka (2020) asserted that the benefits of IBIA makes it very beneficial to students as it allows them to interact with their surroundings to see the abstract phenomenon in a real sense, facilitating a deep understanding of the scientific content, as they discover knowledge through the lens of scientists making them very confident and grounded in the knowledge acquired.

Several researchers have carried out studies on IBIA to ascertain its effectiveness on students test anxiety. For instance, Mwenda and Ndayambaje (2021) in their study examined the effect of inquiry-based teaching on secondary students' anxiety and academic achievement in Biology in Tanzania. The findings of their study revealed that students taught with inquiry-based approach were less nervous during test than those taught through conventional method. Similarly, Okotcha and Oghenejode (2021) examined the effect of self-monitoring strategy on basic science students' test anxiety and achievement on selected Basic Science concepts. The finding of the study also revealed that self-monitoring strategy significantly reduced students' test anxiety. In the same vein, Azowenunebi, Adeyemo and Babajide (2019) study on physics using inquiry based instructional strategy also revealed that studies exposed to IBIA showed lesser test anxiety than those who were not exposed to it. Considering the findings of these studies, one may posit that IBIA helps students' become more conversant with what they learn and are taught, and by doing this may help them feel confident and reduce their anxiety during examinations, irrespective of gender.

Gender is an attribute assigned to individuals based on cultural, social and behavioural differences. Godpower-Echie and Owo (2019) defined it as a socio-cultural construct that assigns roles, attitudes and values considered appropriate for each sex. It is essentially an attribute ascribed to male and female based on biological features (Nwuba et al., 2023b). Gender, as a concept, also has captured the interest of biology educators and teachers in secondary schools regarding the direction of its effect on test anxiety of students. While some found out that female students have higher test anxiety than males others say otherwise. And so, for over the years, no consensus has been reached concerning this argument. For instance, while some researchers (Yusuph, 2016; Jyoti, 2019) in their respective studies reported that female students had higher test anxiety than male students, others (Bada & Idoko, 2021; Olorunfemi-Olabisi, 2014) say the contrary. These inconclusive findings on gender deduce that the issue of gender difference in students' test anxiety is still far from being conclusive. As a result, the study also sought to determine the effect of gender on students' test anxiety when both are taught using inquiry based instructional approach, the rationale behind the study.

To achieve this purpose, the following research questions guided the study:

1. What is the difference in the mean test anxiety scores of secondary school students' taught biology using IBIA and those taught using the Conventional Lecture Method (CLM)?
2. What is the difference in the mean test anxiety scores of secondary school students' taught biology using IBIA with respect to gender?

Hypotheses

The following null hypotheses were tested at 0.05 alpha levels.

1. There is no significant difference between the mean test anxiety scores of secondary school students' taught biology using IBIA and those taught using the CLM.
2. No significant difference exists between the mean test anxiety scores of secondary school students' taught biology using IBIA with respect to gender.
3. There is no interaction effect of teaching methods and gender on secondary school students' test anxiety in biology.

2. METHODS

A non-randomized control group design was used in this quasi-experimental study. 4755 SS2 students, in the 62 government-owned secondary schools in Awka Education Zone, Anambra State, Nigeria, made up the population of the study. The sample size comprised of 52 SS2 biology students (20 males and 32 females) in two intact classes, drawn from two sampled coeducational secondary schools, in the zone using multistage sampling procedure. Data were collected using a biology test anxiety scale (BTAS) adapted from Spielberger and his Associates (1980) test anxiety inventory. BTAS, a 20 multiple choice items designed under a five-point response options of Always (A), Often (O), Sometimes (S), Rarely (R) and Never (N), was validated by three experts for face and content validity. The reliability of BTAS was that of internal consistency established using Cronbach Alpha. To ascertain this, BTAS was administered to an intact class of 27 SS2 students in Aguata Education zone (outside the zone under study) and the scores analyzed to yield a reliability coefficient (r) 0.78.

The study commenced with the briefing of the biology teachers (research assistants) from the two sampled schools, separately on two contacts, prior to the treatment process. In the experimental group, the research assistant was briefed on IBIA, its features, and how to effectively implement the instructional approach, during the teaching and learning process, using the lesson plans developed by the researchers', while in the control group, the teacher was instructed to teach as usual using the lesson plans on CLM, developed also by the researchers. Following the briefing, the BTAS, which served as the pretest score, was given to the two drawn intact classes that were divided into the control (9 boys and 16 girls) and experimental (11 boys and 16 girls) groups. After the pre-testing, the two groups began a 4-week long treatment (teaching) activity. After the treatment (teaching) session, both groups completed a post-test, which was used to calculate the post-test score. The scores from both administered tests were analyzed using mean and standard deviation to answer the research questions while ANCOVA was employed at 0.05 alpha level for testing the null hypotheses.

3. RESULTS AND DISCUSSION

Results

Research Question 1: What is the difference in the mean test anxiety scores of secondary school students' taught biology using IBIA and those taught using the CLM?

Table 1 reveals that experimental group, taught with IBIA, had the test anxiety mean scores of 70.04 and 49.30 in their pretest and posttest respectively while their counterparts taught with CLM had

mean test anxiety scores of 71.52 in the pretest and 65.36 in the posttest. The mean difference of losses in mean for IBIA and CLM, revealed that the experimental group had more reduced test anxiety than the control group with a mean loss of 14.58. The result indicated that teaching biology using IBIA reduced students' anxiety more than CLM.

Table 1. Mean test anxiety scores of students taught biology using IBIA and CLM

Groups	N	Pretest Mean	SD	Posttest Mean	SD	Loss in Mean
Experimental (IBIA)	27	70.04	2.29	49.30	2.74	20.74
Control (CLM)	25	71.52	3.07	65.36	2.80	6.16
Mean Loss Difference		1.48		16.06		14.58

Research Question 2: What is the difference in the test anxiety mean scores of secondary school students' taught biology using IBIA with respect to gender?

Table 2. Mean test anxiety scores of male and female students taught biology using IBIA

Gender	N	Pretest Mean	SD	Posttest Mean	SD	Loss in Mean
Male	11	71.64	2.75	44.73	3.49	26.91
Female	16	68.94	3.41	52.44	3.84	16.50
Mean Loss Difference		2.70		7.71		10.41

Table 2 shows that for the experimental group, the male students had a test anxiety mean scores of 71.64 and 44.73 in the pretest and posttest respectively while their female counterparts had a test anxiety mean score of 68.94 in the pretest and 52.44 in the posttest. The mean difference between the losses in means showed that male students had a reduced mean difference of 10.41 than their female counterparts, when both are taught using IBIA. Hence, it can be deduced that male students expressed lesser test anxiety than their female counterparts after being taught using IBIA.

Null Hypothesis 1: There is no significant difference between the mean test anxiety scores of secondary school students' taught biology using IBIA and those taught using the CLM.

Table 3. ANCOVA test of significant difference between the mean test anxiety scores of students taught biology using IBIA and that of those taught using CLM

Dependent Variable: PreBTAS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	5093.503[a]	4	1273.376	14.061	.000	
Intercept	2429.811	1	2429.811	26.831	.000	
PostBTAS	5016.541	1	5016.541	55.396	.000	
Method	1085.585	1	1085.585	11.988	.001	Significant
Gender	168.050	1	168.050	1.856	.180	
Method*Gender	246.448	1	246.448	2.721	.106	Not Sig.
Error	4256.247	47	90.558			
Total	269639.000	52				
Corrected Total	9349.750	51				

a. R Squared = .545 (Adjusted R Squared = .506)

ANCOVA test result shows that at F-value 11.988, P-value is .001. The null hypothesis is rejected since the P-value at df 1 and 47 is less than 0.05 level of significance. This shows a statistically significant difference, in favor of the experimental group, between students taught biology with IBIA and those taught with CLM. This suggests that using IBIA in the teaching of biology substantially reduced the test anxiety of students more than CLM.

Null Hypothesis 2: There is no significant difference between the mean test anxiety scores of male and female secondary school students' taught biology using IBTS.

Table 4: ANCOVA test of significant difference between the mean test anxiety scores of male and female students taught biology using IBIA

Dependent Variable: PreBTAS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	
Corrected Model	1247.385[a]	2	623.692	6.171	.007	
Intercept	4090.863	1	4090.863	40.477	.000	
PostBTAS	1199.905	1	1199.905	11.873	.002	
Gender	256.827	1	256.827	2.541	.124	Not Sig
Error	2425.578	24	101.066			
Total	136113.000	27				
Corrected Total	3672.963	26				

a. R Squared = .340 (Adjusted R Squared = .285)

ANCOVA test from table 4 reveals that at an F-value of 2.54, the P-value is 0.124. Since the P-value is greater than 0.05 alpha levels at df 1 and 24, the null hypothesis is not rejected. This indicates that no significant difference exists between the mean test anxiety scores of male and female students when taught biology using IBIA. Hence, IBIA is not gender biased.

Null Hypothesis 3: There is no interaction effect of teaching methods and gender on secondary school students' test anxiety in biology.

The result of the ANCOVA test from table 3 shows that at F-value 11.988, P-value is 0.106. Since the P-value is greater than 0.05 alpha levels at df 1 and 47, the null hypothesis is not rejected. Showing that there is no interaction effect of gender and methods of teaching on test anxiety of students in biology. This implies that the two-way interaction (methods*gender) is not a significant factor on students' test anxiety in biology.
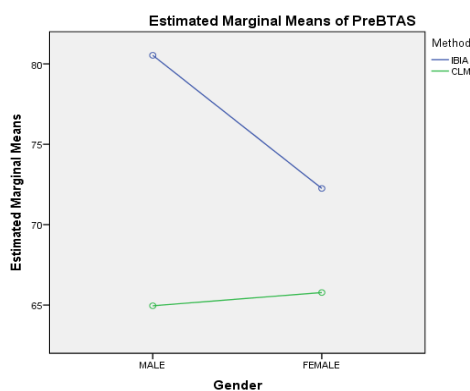

Figure 1. Profile Plot of Interaction Effect of Teaching Methods and Gender on the test anxiety of Students in Biology

Discussion

The study revealed that IBIA effectively reduced students' test anxiety in biology more than the CLM. This reduction in students' test anxiety was proved statistically significant by the test of the null hypothesis. This significant difference, of IBIA over CLM, can be attributed to the nature of IBIA as it provided students with hands on minds-on activity based opportunities that allowed them explore the environment, ask questions, construct information and discover new knowledge themselves, and by so doing, become more confident, understand better, develop problem solving skills and enjoy the teaching and learning process. The findings of this study lends credence to that of Galle and Kukwi (2020), Kumar, et al. (2021), Acar, et al. (2022) and Jekayinfa, et al. (2023) who reported in their respective studies that hands-on minds-on activity based instructional approaches, similar to IBIA, significantly reduced test anxiety among students.

On gender, the study revealed that IBIA significantly reduced male students' test anxiety in biology more than their female counterparts. This, more, reduced test anxiety for males may be attributed to the biological nature of boys. For instance, most research have shown that female students prefer normal classroom discussion to any situation that involves hands-on (doing) activities, unlike the males. This is yet another reason why the subject is enjoyed mostly by girls (as seen in their pretest where they exhibited lesser test anxiety). But on using IBIA, the research participants (students) were exposed to variety of activity based situations that had them observing, designing and carrying out experiments, collecting data and drawing inference, which go beyond the classroom walls (which most males find appealing). However, although the difference exists, the test of the null hypothesis proved that this difference is not statistically insignificant, when tested. This proves that IBIA is a gender friendly approach that reduces students test anxiety in biology. The findings of this study concur with that of Oludipe and Awokoy (2010), Kour, et al. (2021) that gender has no significant influence on students' test anxiety when they are taught using activity based instructional approaches. To an extent, the findings of Jyoti (2019), Hussein and Csikos (2023) disagrees with the current finding, stating that although activity based instructional approaches, similar to IBIA, reduced students' test anxiety, the difference is statistically significantly in favour of the females.

On interaction effect, the study revealed that there was no interaction effect of gender and teaching methods on students' test anxiety in biology. This finding concur with that of Jekayinfa, et al. (2023) who reported that gender and teaching methods have no interaction effect on students' test anxiety in mathematics, but disagrees with that of Jyoti (2019).

4. CONCLUSION

The study explored the effect of inquiry based instructional approach (IBIA) on secondary school students' test anxiety in biology. The results, from the collected analyzed data, revealed that IBIA significantly reduced secondary school students' test anxiety in biology, irrespective of gender, although more for males than females. Based on the findings, the study concluded that IBIA is a gender friendly instructional approach that reduces students test anxiety in biology through its provision of an activity based learning environment that boosts students' confidence, promotes acquisition of problem solving skills and meaningful learning.

Recommendations

Based on the findings of the study, it was recommended that:

1. IBIA should be adopted by teachers in teaching biology in secondary schools, through the creation of opportunities or situations that have students hands on minds-on actively involved in the teaching

and learning process, as this will help improve students' confidence and reduce their anxiety during tests.

2. Education stakeholders (government and professional bodies) should organize seminars, workshops and conferences for biology teachers to familiarize and train them on innovative instructional approaches such as IBIA.

3. Practical oriented textbooks should be approved for usage by curriculum planners as this will help teachers extensively plan and organize practicals that will expose students to hands-on minds-on activities that can reduce their anxiety in biology examinations.

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