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# Lowering Anxiety of Students Towards Science Using a Culturally Responsive Pedagogy: A Test of the Efficacy of Culturo-Techno-Contextual Approach

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**A B S T R A C T**

Culturo-Techno-Contextual Approach (CTCA) is a culturally responsive teaching strategy that empowers African students to learn science meaningfully in the digital age. CTCA integrates culture, technology, and locational context to enhance students' comprehension of scientific concepts. This study examined the effectiveness of CTCA in reducing students learning anxiety towards science concept. A pretest-posttest, non-equivalent group design was adopted. The sample comprised 121 senior secondary II students (equivalent to grade 11) from two purposively selected schools in Lagos State. The Nutrition Anxiety Scale, which had a reliability coefficient of 0.70, was used data collection. The treatment period lasted four weeks following the pretest. The experimental group was taught using the CTCA, while the control group received conventional lecture-based instruction. The results revealed that those students who were taught using the culturo-techno-contextual approach had a significantly lower level of anxiety than the comparison group [F (1, 198) = 16.54; p < 0.05]. A statistically significant difference was not found based on gender [F(1,49)=.49; P >0.05]. Therefore, within the limitations of this study, it was concluded that CTCA is an effective teaching approach for lowering anxiety towards science. It is recommended that CTCA be adopted in teaching scientific concepts.

## 1. Introduction

Culture has historically been utilised in educational research to address issues of equality for low-income and racial and ethnic minority students. This approach allows us to understand classrooms as cultural environments and recognise the importance of students' cultural identities as learning tools (Kim, 2020). The concept behind cultural teaching methods is that introducing new concepts through familiar

systems facilitates easier understanding. This cultural orientation forms the basis of the Afrocentric teaching model. This model is rooted in African cultural values and leverages the knowledge of parents, elders, and other relatives, often transmitted orally through generations. Awaah et al. (2023) note that Africa has predominantly adopted Western teaching models in its effort to equip students with the skills, knowledge, and attitudes necessary to advance various economic sectors. This adoption is largely attributed to the continent's colonial history, wherein different parts of Africa were influenced by the educational systems of their respective Western colonisers.

Despite the development of numerous teaching methods within Western culture, these methods have had limited success in engaging African students in STEM subjects (Okebukola, 2020; Adam et al., 2024). Given the growing emphasis on culturally relevant pedagogies in education, it is imperative to move beyond the notion of Western knowledge superiority and embrace our indigenous knowledge systems for effective teaching and learning in STEM. Amidst these discussions, there is optimism for indigenous teaching strategies led by Africans, specifically the Culturo-Techno-Contextual Approach (CTCA).

The Culturo-Techno-Contextual Approach (CTCA) is the culmination of over four decades of research on effective methods for teaching STEM subjects to African students. This approach aims to facilitate meaningful learning and enhance the application of STEM knowledge to address contemporary real-world issues in Africa and globally. Developed by Peter A. Okebukola and introduced in 2015 at the University of Ibadan, Nigeria, CTCA is designed to overcome traditional barriers to effective learning (Okebukola, 2020). CTCA integrates three key frameworks: (a) the cultural context, which encompasses the cultural backgrounds of all learners; (b) technology mediation, reflecting the increasing reliance of teachers and learners on technological tools; and (c) the locational context, representing the unique identity of each school and the relevance of local examples and case studies in science education.

This approach offers a culturally and contextually relevant teaching strategy that empowers African students to acquire STEM knowledge and skills meaningfully and confidently in the digital age. It reframes STEM concepts not as foreign or abstract ideas but as elements rooted in their culture and daily experiences. CTCA is grounded in Kwame Nkrumah's ethnophilosophy for cultural relevance, Martin Heidegger's techno-philosophy for technological integration, and Michael Williams' contextualism for situational application. CTCA posits that incorporating cultural, traditional, or indigenous knowledge into education significantly enhances students' understanding of science. When education is built on a student's cultural and indigenous knowledge, conventional barriers to comprehending scientific concepts are dismantled.

Okebukola et al. (2016) examined the effects of the Culturo-Techno-Contextual Approach (CTCA) on students' learning outcomes in challenging ecology concepts in biology. The study found that CTCA significantly improved students' academic performance and reduced their anxiety levels in biology classes. Observation data indicated that students were enthusiastic about discovering the scientific relevance of their culture, as each lesson was intricately connected to their local context. This finding aligns with Onowugbeda et al. (2024), who investigated the impact of CTCA on students' scientific explanations in the context of variation and evolution, another challenging biology concept. Adam et al. (2021) concluded that incorporating cultural and indigenous knowledge, as well as practical examples from students' local contexts, enhances African students' comprehension of scientific concepts and improves learning outcomes.

To attract more students to study science, it is essential to significantly reduce their anxiety levels in science classrooms. Anxiety in science learning is characterised by feelings of tension and fear that impede students' engagement with scientific activities (Oladejo et al., 2023). The desire to enhance students' performance in biology and other science subjects in Nigeria has sparked considerable interest in understanding how students learn and how to facilitate meaningful learning. For students to learn effectively, they must be interested in the subject matter; otherwise, meaningful learning is unlikely to occur. According to Oladejo et al. (2023), recent interactions with science teachers, particularly in government-owned schools that accommodate a large percentage of Nigeria's secondary school population, indicate that many students are reluctant to remain in class during science periods, including biology. While several factors might contribute to this behaviour, most teachers attribute it primarily to anxiety.

Anxiety among students can be influenced by external factors such as stress stemming from academic challenges. The positive aspect is that anxiety can be effectively managed or treated. It is a normal and healthy emotion (Onowugbeda et al., 2023). While high levels of anxiety can hinder

concentration and memory recall, both crucial for academic success, it can also be beneficial by sharpening focus on important tasks during class activities (Parker et al., 2021; Pekrun & Marsh, 2022). Given the dual nature of anxiety—being both helpful in small amounts and distracting in large amounts—it warrants thorough investigation. A review of the literature on addressing this issue reveals promising findings from studies exploring culturally relevant pedagogies to enhance student achievement and sustain their interest in learning (Onowugbeda et al., 2023; Oladejo et al., 2023). Culturally relevant pedagogies are strategies that teachers can adopt to empower students, enabling them to achieve long-term academic success (Ladson-Billings, 2021; Onowugbeda et al., 2023), develop cultural competence (Akintoye et al., 2024; Gbeleyi et al., 2023), and build the capacity to critically evaluate issues around them (Adam et al., 2024). These studies have found that culturally relevant pedagogies promote active engagement in science learning, suggesting they may significantly reduce students' anxiety towards learning biology.

Over the years, there has been growing recognition of the crucial role that women play at home, in schools, and within the broader community. There have been increasing concerns regarding the participation of women in various domains, including politics, social interactions, cultural activities, psychological well-being, economic efforts, spiritual engagements, and advancements in science and technology. The influence of gender on students' learning outcomes has emerged as a significant area of inquiry (Chen et al., 2016). Gender encompasses a range of characteristics that differentiate males from females, particularly in the context of men and women. These distinguishing characteristics may pertain to biological sex, social roles, or gender identity, depending on the context. Gender disparities in science achievement and capabilities have continued to be a matter of concern, as there is a notable underrepresentation of women at the highest levels of Science, Technology, Engineering, and Mathematics (STEM) fields (Asante, 2010).

Research has increasingly focused on understanding how gender differences influence the learning outcomes of secondary school students (Dang et al., 2016; Lamb et al., 2018). The influence of gender on students' learning outcomes including learning anxiety remains a contentious issue in education, with conflicting research findings adding to the complexity of the debate. Ajai and Imoko (2015) argue that gender significantly affects knowledge retention in science subjects. Zhan et al. (2015); specifically found that male students outperformed their female peers in grasping certain STEM concepts. Conversely, Bailey et al. (2020) observed that male students were more likely to participant in science classroom activities than females. In contrast, Nzewi (2010) concluded that gender does not significantly impact students' learning outcomes in science subjects. These varying findings highlight the need for further research into the effect of gender on students' anxiety towards biology concepts. It is from the foregoing that the study intends to investigate the impact on CTCA on reducing learning anxiety of students towards biology and examine the effect of gender on their anxiety level.

**Research Question**

This research question guides the study:

1. Will there be a statistically significant difference in the anxiety level of students taught with CTCA and the lecture method?
2. Will there be a statistically significant difference in the anxiety of male and female students taught with CTCA?

**Research Hypothesis**

1. There will be no statistically significant difference in the anxiety level of students taught with CTCA and the conventional lecture method

There will be no statistically significant difference in the anxiety of male and female students taught with CTCA

## 2. Methodology

This study employed a pretest-posttest, non-equivalent group design, incorporating both an experimental and a control group. Two senior secondary schools within Lagos State education district V were purposefully selected for the study. The primary criterion for eligibility was students' access to internet-enabled devices, particularly after school hours. Participants were Senior Secondary School Year Two (SS2—equivalent to grade 11) students. A total of 121 SS2 students were involved in the study, with 52 students (31 females and 21 males) in the experimental group and 69 students (39 females and 30 males) in the control group. The average age of the students was 15 years.

Students' anxiety levels to nutrition concept were measured using a version of a modified form of the Science Anxiety Scale (SAS) initially developed by Fraser, (1983). For this study, we modified the SAS to form the Nutrition Anxiety Scale. This instrument was validated by a validation panel comprising five seasoned biology teachers and three science education experts to ensure it measures what it is

expected to measure. The validity process ensured that the words that describe how students feel were adjudged to be appropriate for use in the context of this study. The validation panel's opinion led to ten positive and ten negative words that best described how students feel in learning nutrition concepts. The students were required to write either a yes or no on each word that described how they felt in the class when the topic was being taught. The total anxiety score for each student was found by adding the scores for the 20 keywords. The reliability of the instrument was determined using the test-retest procedure. In order to do this, we gave the Nutrition Anxiety Scale to a group of SS2 students who were similar to the study group but not the study group. After two weeks of administering the instrument, we went to the same school for the second time and administered the same instrument to the same set of students. The data was analysed using IBM-SPSS version 23, and a reliability coefficient of 0.70 was obtained.

***Treatment Procedure***

The biology teacher of the experimental group was trained in the use of CTCA and after the training which lasted for three weeks, three sessions of micro-teaching exercise were held. Students in the control group were taught using the conventional lecture method, while in the experimental class, the teacher taught nutrition following the five-step CTCA protocol at every lesson (see www.ctcapproach.com for details). The treatment lasted four weeks. The steps are as follows:

As pre-lesson activity, the teacher informed the students ahead of time (about a week ahead) of the topic to be learned in class, in this case nutrition, and requested that they (a) reflect on indigenous knowledge or cultural practices and beliefs associated with the topic or concept. The students were made aware that such reflections are to be shared with others in class when the topic is to be taught; and (b) using their mobile phones or other Internet-enabled devices, search the web for resources relating to the lesson (first technology flavor of the approach).

At the start of the lesson and after the introduction by the teacher, students were grouped into mixed ability, mixed-sex groups (10 students in a group) to share individual reflections on (a) the indigenous knowledge and cultural practices and beliefs associated with the topic; and (b) summaries of ideas obtained from web resources. All such cultural and web-based reflections were documented and presented to the whole class by the group leaders. The teacher wraps up by sharing his/her indigenous knowledge and cultural practices associated with the topic.

The teacher progresses the lesson, drawing practical examples from the immediate surroundings of the school. Such examples can be physically observed by students to make the concept real and less abstract. This is one of the "context" flavors of the approach. The teacher sprinkled lesson delivery with some content-specific humor. As the lesson further progresses, the class was reminded of the relevance of the indigenous knowledge and cultural practices documented by the groups for meaningful understanding of the concepts. Areas of misconceptions associated with cultural beliefs were cleared by the teacher. At the close of the lesson, the teacher sends a maximum 320-character summary of the lesson (two pages in SMS) via WhatsApp to all students. After the first lesson, student group leaders were saddled with the responsibility of composing the summaries and sending them to the WhatsApp group. This is another of the technological flavor of the approach.
Examples of cultural knowledge or practices related to nutrition mentioned during the lessons are:

Staple Foods was explained using examples of staple foods in Yoruba culture, such as yams (isu), cassava (gari), and plantains (dodo). This was used to further explain the nutritional content of these foods, including carbohydrates for energy (See figure 1).

Figure 1. Local Staple Food in Nigeria (Lola, 2022)

Balanced Meals was described with a traditional Yoruba meal like pounded yam (iyan) with vegetable soup (efo riro) that contains leafy greens, fish, or meat. This illustrate a balanced diet with carbohydrates, proteins, vitamins, and minerals (see figure 2).

Figure 2. Nigerian Made Iyan (Pounded Yam) and Vegetable Soup (Efo Riro)
(Kalejaiye, & Kalejaiye, (2021)

Indigenous plants and herbs such as bitter leaf (ewuro) and moringa (ewe igbale) was used to exemplify medicinal plants (see figure 3). This highlight their nutritional benefits and how they are used to enhance health and nutrition in the community.

Figure 3. A Local Bitter Leaf
(Ewuro) (Yusram, 2024)

The control group underwent a four-week period of learning experiences focused on "Nutrition" utilizing the lecture method. The instructional process in the control group followed a series of steps outlined below:

**Step one**: The teacher revises the previous lesson and introduces the new topic (nutrition) to the students
**Step two**: The teacher explains the concepts to the students
**Step three**: The teacher writes notes on the board, and students write in their notebooks
**Step four**: The teacher summarizes the lesson and gives students an assignment while the students write the assignment in their notes.
**Step five:** The teacher requests students' books and marks and returns them.

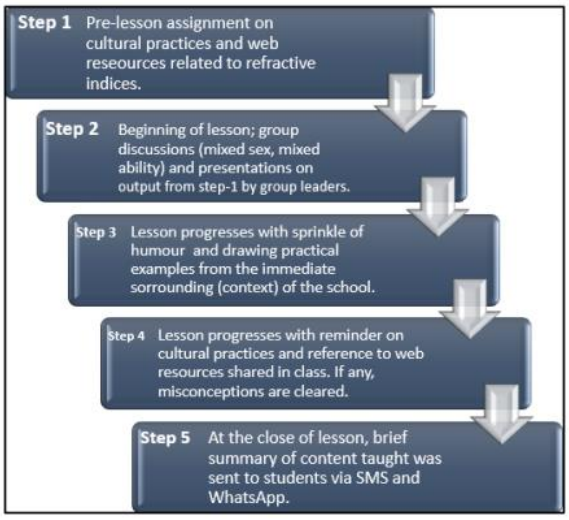


Figure 4. Implementation of CTCA

## 3. Results and Discussion

The analysis followed a step-by-step procedure with the test of the parametric assumptions coming first before we applied the ANCOVA statistic on the data. The Levene's test (test of homogeneity) confirmed the two groups were not significantly different from one another ($F = 2.47$; $p > 0.05$). Having met these assumptions, we applied the ANCOVA statistic on the anxiety scores of the students in the two groups, using the scores generated from the anxiety test as the dependent variable, the teaching methods as the fixed factor, and the pretest scores as the covariate**.** To answer research question one which investigated if there was a statistically significant difference in the anxiety level of students taught with CTCA and the lecture method, the data was subjected to descriptive statistics of mean and standard deviation as shown in Table 1.

Table 1. Mean and Standard Deviation of Anxiety Test Scores of the Two Groups

| Group | Mean | Std. Deviation | N |
|---|---|---|---|
| Experimental group | 26.55 | 4.22 | 52 |
| control group | 22.75 | 3.56 | 69 |
| Total | 24.98 | 4.367 | 121 |

The result in table 1 showed that students in the experimental group had a lower degree of anxiety (Mean = 26.55; SD = 4.22) than the control group (Mean = 22.75; SD = 3.56). Thus, to ascertain whether the observed difference is statistically significant and not due to error variance, the obtained

result was subjected to inferential testing as shown in Table 2.

Table 2. Test of Significance Between the Experimental and Control Groups

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 311.002a | 2 | 155.501 | 9.829 | .000 | .190 |
| Intercept | 601.897 | 1 | 601.897 | 38.045 | .000 | .312 |
| PREANX | 6.426 | 1 | 6.426 | .406 | .526 | .005 |
| GROUP | 261.716 | 1 | 261.716 | 16.542 | .000 | .165 |
| Error | 1328.952 | 198 | 15.821 | | | |
| Total | 55915.000 | 121 | | | | |
| Corrected Total | 1639.954 | 120 | | | | |

a. R Squared = .190 (Adjusted R Squared = .170)

The result in Table 2 shows that at entry level, students of both groups (CTCA and Lecture method) were not significantly different from one another in their anxiety score (pretest scores, $p = 0.53$). However, after treatment, the result showed that the experimental group significantly outperformed [$F(1, 198) = 16.54$; $p < 0.05$] the control group. Based on this result, the hypothesis which states that there will be no statistically significant difference in the anxiety level of students taught using the traditional lecture method and those taught using the culturo-techno-contextual approach is therefore rejected.

Research question two sought to examine if there was a statistically significant difference in the anxiety level of male and female students taught with CTCA. The quantitative data was subjected to descriptive statistics of mean and standard deviation as shown in table 3.

Table 3. Mean and Standard Deviation of Anxiety Level of Male and Female Students Taught with CTCA

| Gender | Mean | Std. Deviation | N |
|---|---|---|---|
| Female | 23.25 | 2.63 | 31 |
| Male | 23.19 | 2.65 | 21 |
| Total | 23.22 | 2.62 | 52 |

The result in Table 3 indicates that the mean scores of the female (23.50) and male (23.19) students in the CTCA class are comparable. To ascertain whether this observed comparable difference is real or attributed to error variance, this result was subjected to inferential testing in Table 4.

Table 4. Test of Significance Between the Female and Male Students Taught with CTCA

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 15.951[a] | 2 | 7.976 | 1.278 | .285 | .035 |
| Intercept | 333.686 | 1 | 333.686 | 53.487 | .000 | .433 |
| PRE_CRI | 14.888 | 1 | 14.888 | 2.386 | .127 | .033 |
| GENDER | 3.049 | 1 | 3.049 | .489 | .487 | .007 |
| Error | 436.706 | 49 | 6.239 | | | |
| Total | 6276.000 | 52 | | | | |
| Corrected Total | 452.658 | 51 | | | | |

a. R Squared = .035 (Adjusted R Squared = .008)

The result obtained in Table 4 revealed that there was no significantly in the anxiety scores of male and female students exposed to CTCA [$F(1,49)=.49$; $P > .05$].

### *Discussion of Results*

The first research question sought to determine if there was a statistically significant difference in the anxiety level of students taught using CTCA and those using the conventional lecture method. The results indicated that CTCA significantly lowered students' anxiety level towards nutrition concepts. This finding aligns with previous studies by Onowugbeda et al. (2024) Oladejo et al. (2023), which tested the effectiveness of CTCA in lowering students' anxiety level in subjects like biology, chemistry, and physics, and found it to reduce anxiety and enhanced meaning learning.

The alignment of the current study's findings with previous research underscores the importance of

incorporating culture, technology, and context in educational approaches, particularly through the Culturo-Techno-Contextual Approach (CTCA). The notable reduction in students' anxiety levels regarding nutrition concepts can be attributed to the fundamental elements of CTCA. The cultural context framework ensures that teaching methods and materials resonate with students' cultural backgrounds. When students see their culture reflected in classroom activities, it strengthens their connection to the material, making it more relatable and less intimidating.

As outlined in the treatment procedure, the "culturo" aspect of CTCA involved asking students to document indigenous knowledge and cultural practices related to the topics covered. This exercise enabled students to recognize that their indigenous knowledge and cultural practices are valuable and directly applicable to understanding the concept of nutrition. For instance, when medicinal plants were linked to the local Yoruba bitterleaf (ewuro), known for curing constipation, it made the class engaging and enhanced students' active participation in the learning process (see Figure 3). By integrating culturally relevant examples, students found the lessons more interesting and were more involved, thereby reducing anxiety and promoting meaningful learning.

Technology mediation, the second pillar of CTCA, capitalizes on the growing integration of technological tools in education. This involves using technology in group discussions and presentations, assigning pre-lesson tasks and engaging on class WhatsApp platforms. Can technology use reduce students' anxiety in their learning processes? Absolutely, and here's how. Today's learners are digital natives—they are inherently familiar with computers and the internet, having been born into a digital world. This familiarity means they feel comfortable and happy engaging in activities enabled by technology. Have you noticed how children intuitively use TV and DSTV remotes without formal instruction? They also exhibit excitement when handling their parents' phones, eager to play games or chat on social media, activities they learn independently. This comfort stems from a lack of fear in using these devices. Integrating learning activities with technology builds on this existing foundation. This facilitates learning in a preferred manner and steer students away from potentially unhealthy uses of their gadgets. Thus, technology mediation reduces anxiety and aligns educational practices with the students' natural inclinations and competencies.

The second research question examined whether there was a significant difference in the anxiety level of male and female students exposed to CTCA. The analysis revealed that there was no statistically significant difference between the anxiety level of male and female students. This result is consistent with findings from other studies by Oladejo et al. (2022), Ademola et al. (2023), and Onowugbeda et al. (2024), which also reported no gender-based differences in anxiety levels. Numerous studies have demonstrated that students, both male and female, learn more effectively and experience less anxiety when they feel comfortable sharing ideas with their peers (Theobald et al., 2017; Downing et al., 2020; Onowugbeda et al., 2022). A common source of student anxiety is the fear of being judged negatively by classmates and teachers (Downing et al., 2020).

To address this, the teacher in the CTCA group implemented strategies to foster a sense of community and establish group norms. This involved assigning roles within groups, setting clear expectations with defined goals, objectives, and deadlines, and organizing activities that allowed students to contribute their unique expertise to the project. Some students might struggle to recall relevant indigenous knowledge and cultural practices within their groups. To support these students, the teacher and peers provided examples that served as a collective resource. This consistent approach enabled students to thoughtfully and explicitly connect their cultural practices to relevant scientific concepts. The CTCA classroom, where the students felt at ease sharing their perspectives on cultural practices related to the concepts being studied, effectively reduced anxiety towards biology.

## 4. Conclusion

The goal of this study was to explore the potency of CTCA being a culturally relevant pedagogy in reducing anxiety level towards concepts. Findings show that CTCA was effective in lowering students anxiety level towards biology concepts as compared to the traditional lecture method. Additionally, CTCA appears to be a promising tool for addressing gender disparities in science performance.

The study also offers new perspectives on the importance of group activities and cooperative learning. It underscores the need to encourage students from diverse cultural backgrounds to interact with one another to enhance their biological reasoning and communication skills. Anxiety about a particular subject often stems from a lack of confidence, which can arise if students miss classes,

neglect assignments, or refrain from asking questions. This reluctance to admit gaps in their knowledge can exacerbate their anxiety (Silaj et al., 2021). To alleviate this anxiety, it is beneficial to foster an inclusive environment where students are encouraged, provided with numerous opportunities to collaborate, ask questions, and actively participate in the learning process. Educators in biology and other fields should recognise the benefits of culturally immersive and context-sensitive teaching approaches such as CTCA. It is advisable to incorporate training on the CTCA into professional development programs for pre-service biology teachers. Furthermore, the Ministry of Education and curriculum developers should advocate for the adoption of culturally relevant and contextually responsive teaching methods among school science teachers, including opportunities to integrate local content into textbooks.

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