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Effects of an App Enriched with Culturo-Techno-Conceptual Approach on Epistemic Curiosity of Biology Students.

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Abstract: *Curiosity is the hunger and the thirst that give birth to knowledge. Generally, studies have shown that students in secondary school are showing lack of interest in learning biology as one of the core science subjects offered in secondary schools. One of the major factors responsible for this situation is the instructional strategy used by the teachers. In the light of this, the primary purpose of this study is to investigate the effect of an app enriched with CTCA on the epistemic curiosity of biology students. The potency of the app was tried out in this study with 154 senior secondary two biology students, equivalent to (11th grade) with an average age of 14 years. The research design was a quasi-experimental pre-test, post-test non-equivalent group design. Data on epistemic curiosity was collected using a curiosity rating scale. The reliability coefficient of the instrument was determined to be 0.72. Data collected were analyzed on IBM SPSS using ANCOVA. The 68 students in the experimental group who were taught nitrogen cycle using an app enriched with CTCA had a significant boost in their epistemic curiosity {$F(1,151) = 0.00; p < .05$} than their control group ($N = 86$). Result also revealed that there is no statistically significant difference for gender and school location respectively; $F(1,151) = 0.0866; P > .05$. In conclusion, data from this study support the potency of the app enriched with culturo-techno-contextual approach in boosting the epistemic curiosity of biology students.*

Keywords Biology; Culturo-Techno- Contextual Approach; Curiosity.

Introduction

Science, Technology, Engineering and Mathematics (STEM) Education is a curriculum based on the idea of educating students in the four specific disciplines of science, technology, engineering and mathematics. It is a new development in science education with an increased attention by societal stakeholders worldwide.

STEM education offers a great deal of opportunities for the development of any nation, as it helps in producing citizens that will shape the future of their countries in terms of economic growth and development. Africa, as a continent will benefit in the following areas:

1. The production of scientists, engineers, great mathematicians that will put Africa on the scientific world map.
2. Development of the abundant material resources available in Africa to meet world standard.
3. Put an end to the continued dependence by Africans on imported goods, thereby making Africa an exporting continent.
4. Add values to African resources
5. And by these, Africa will no longer be a consumer of technologies from developed countries, but rather, inventors and innovators.

Generally, Africa and Nigeria in particular is currently struggling with poor development, deficient infrastructures and unemployment; the ailing economies of most African countries like Nigeria and South Africa have been in the news very often. This is blamed on the type of education provided, which is not in tandem with the current trends in scientific development and needs, as it is theory based. The need to reverse the trend is therefore inevitable and this must begin with building of human capacity in science, technology, engineering and mathematics. Generally, it could be stated that the attitude of youths toward STEM education and STEM related professions is negative and could be partly responsible for the low level of development in Africa and Nigeria in particular. For instance, despite the great potential for agricultural production in Africa, it has been reported that about 73% of poor people living in the rural areas survive on less than a dollar a day. In Nigeria, many people have little prospect for a better future, lacking hope, purpose or dignity; they watch from society's sidelines as they see others pull ahead to greater prosperity. Far too often gender, ethnicity or parents' wealth still determines a person's place in society (UNDP Human Development Reports, 2005; 2019). Furthermore, from the statistics available at the Millennium Development Goal's Technical Support Centre (2004), it was discovered that out of the world's hungry people, about 200 million people are found in the African continent; also, from

UNDP (2005) suggested that about one third of Africa's population is malnourished. Africa has the highest number of people living in extreme poverty in the world and is the only continent where there is deficiency in food production over the years. There has been little or no investment in the rural areas; there is inadequate access to modern technologies; HIV/AIDS, natural disasters, deforestation, environmental degradation, loss of biodiversity; dependency on foreign aid and poor entrepreneurial competencies and skills.

The need to build a virile workforce led to a reform in the national curricula for Senior Secondary School Certificate, but, in spite of the efforts to revamp STEM education in Nigeria, there has been concerns that most Nigerian youths are not scientifically literate and cannot take full participation in 21st century world economy (Jang, 2002; Ajewole, 2005).

Furthermore, the National Assessment of Educational Progress (NAEP) report shows that less than 2% of science students in Nigeria meet the National Governing Board's definition of proficiency in science (NCES, 2001). In addition, students' achievement scores in science often fall below international standards. This implies that their knowledge and understanding did not meet the level needed for being competent in the global economic market not to mention providing manpower needs for STEM professions.

In addition to the above statements, NCES (2001), reported that the second International Science Study (SISS) revealed that Nigerian students came last in primary science and last but one in secondary science among the participating countries of the world.

In 1972, Renner and Stafford stated three major objectives of science education, now evolved as STEM education namely;

1. To develop in the learner a command of rational powers
2. To develop in the students, the ability and confidence to inquire
3. To develop an understanding of the changing nature of the environment, in terms of matter, life, energy and their interaction.

The achievement of these objectives leads to scientific literacy. However, for all the above listed objectives to be achieved, students' curiosity and motivation must be very high.

Curiosity

Daniel Berlyne is considered one of the proponents in the study of curiosity. His neurophysiological view associated curiosity with exploratory behaviour in students. He also identified two forms of exploratory behaviour namely, diverse exploratory e.g. seeking relief from boredom and specific exploratory e.g. uncertainty, conceptual conflict. From Berlyne's work, specific curiosity is of most interest in STEM education, as it is in the context of epistemic curiosity i.e. the brand of arousal that motivates the quest for knowledge and is relieved when knowledge is acquired. (Berlyne, 1960). This implies that epistemic curiosity results in specific exploration which ultimately resolves the uncertainty or conceptual conflict and returns the individual to a relaxed muscle level.

Epistemic curiosity, is the intrinsic desire to acquire new knowledge which enhances learning (Hidi, 2016), and it is a strong predictor of academic achievement and job performance (Mussel, 2013; Von Stumm, Hell, & Chamorro-Premuzic, 2011). In spite of the importance of curiosity to everyday learning, until recently, the topic has been largely ignored in experimental psychology and cognitive neuroscience, furthermore, we lack an understanding of the cognitive and neural processes underlying the nebulous concept of curiosity. Fortunately, new experimental research has begun to shed some light on how curiosity modulates brain activity and memory processes.

Furthermore, a major problem in the research about the concept of curiosity has been the inconsistency of terminology, operational definitions, and measurement strategies; this has hindered the progress in the study of curiosity. For instance, intrinsic motivation is often defined in ways that are identical to curiosity, which also has underscore its importance. Ryan & Deci (2000) opined that perhaps no single phenomenon reflects the positive potential of human nature as much as intrinsic motivation, the inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn. In a similar vein, the concept of flow, being fully immersed in an activity that is challenging, enjoyable, and which requires the full deployment of one's skills can be described as an extreme variant of curiosity. Other terms that are used synonymously with curiosity include interest, novelty-seeking, and openness to experience, among others. Unfortunately, few scientists have connected these often-isolated bodies of research; and as a matter of fact, there is scanty research from Africa continent on the topic.

As noted above, curiosity is related to several other psychological constructs, all of which are concerned with the way people regulate and direct their attention in the presence of novel or valued environmental stimuli. Although these terms have been used somewhat interchangeably, this tendency has obscured the fact that the essential qualities of curiosity connote a high degree of receptivity and willingness to engage with novel stimuli and there is need to dichotomize the two. Although, curiosity has overlapping attributes with intrinsic motivation, flow, and other variables, however, the unique characteristics that have emerged across research projects inform the dichotomy. Among several other definitions, curiosity could mean; being interested in new things and possessing an open and receptive attitude toward whatever is the target of attention (Bishop et al., 2004). When people feel curious, they devote more attention and time to an activity, process information more deeply, remember information better, and are more likely to persist on tasks until goals are met (Silvia, 2006). Therefore, the immediate function and importance of curiosity is to incite learning, exploration, and immerse oneself in the activity that initially stimulated the deployment of intentional resources and thereby create special interest in that activity.

From the ongoing discourse, curiosity is a phenomenon that is so important to the knowledge industry, skill acquisition, understanding of human society and how we relate with the environment; any society that will experience growth and development must ensure that its people are highly curious and motivated towards novelty and new things. Furthermore, no scientific breakthrough can be achieved without curiosity.

Curiosity and Motivation: The Link

Curiosity is an appetitive state involving the recognition, pursuit, and intense desire to investigate novel information and experiences that demand one's attention (Kashdan and Steger 2007). Silvia (2012) opined that, in this generation, the concept of curiosity as a source of intrinsic motivation is prevalent in most areas of psychology.

From this perspective, curiosity motivates people to explore and learn for their own sakes. This positive role could be explained by several mechanisms. On the one hand, curiosity is a source of intrinsic motivation involving the tendency to explore the environment and focus attention on activities that facilitate learning, competence, and self-determination (Kashdan et al. 2004; Silvia 2012). This could indicate that curiosity facilitates curious students' experience of higher levels of engagement (Hulme et al. 2013; Silvia 2012). Moreover, curiosity provides a better distribution of attention and energy to identify and follow signs of challenge; it allows behavioral exploration of challenging activities; and it leads to deep engagement and absorption in these activities (Kashdan 2004), which can also play a positive role in students' engagement.

Epistemic curiosity is interested in finding true information that is activated by conceptual undetermined or complex ideas such as (theories of knowledge, mental cross words (Ünal, 2005). In the same vein, Schmitt and Lahroodi (2008) investigated the value of curiosity and the scope of knowledge, they were of the opinion that curiosity has an appetitive value, viewing curiosity as motivationally original desire to know, which arises from having one's attention drawn to the object and that in turn sustains one's attention on it. These authors explored several sources of the epistemic value of curiosity; they discovered that:

1. Curiosity is tenacious: whether a proposition is true leads to curiosity about related issues.
2. It is related to our field of interest.
3. Curiosity is largely independent of our interests. It fixes our attention on objects in which there was no initial interest, thereby broadening our knowledge on it

Effect of instructional Methods on Students' Curiosity

Curiosity and motivation have been found to play important role in the study habits of students, most especially the science students. In a related study on the study habits of Biology students, Ebele & Olofu (2017) found that good study habits will contribute to a successful academic future as well as leads to good grades while good grades in turn lead to admissions into better colleges and universities, possibly with a scholarship thrown in. Developing good study habits is very crucial for every student irrespective of his level of education; as it boosts students' ability to be self-disciplined, self-directed and ultimately successful in their degree programmes. They further maintained that effective study habits are important part of the learning process.

Scaffolding is an instructional strategy that emphasizes the teaching of new skills by engaging students collaboratively in tasks that would be too difficult for them to complete on their own. This teaching strategy emphasizes on the role of teachers and other more skillful persons in supporting the learner's development and providing support structures to get to that next stage or level (Nonye & Nwosu, 2011). The instructional strategy originated from Lev Vygotsky socio-culture theory and his concept of Zone of Proximal Development (ZPD). His socio-cultural theory spelt out that social interaction plays an important role in the development of cognition. In his view, the learner does not learn in isolation, rather learning is strongly influenced by social interactions, which take place in meaningful contexts. The Zone of Proximal Development (ZPD) is that area between what a learner can do independently (mastery level) and what can be accomplished with the assistance of a competent adult or peer (Instructional level). It is believed that any learner could be taught any concept effectively using instructional scaffolding strategy by applying the scaffolding at the ZPD. An important aspect of scaffolding is that the scaffolds are temporary.

Ibritam, Udofia, and Onweh (2015) asserted that as the learners' abilities increases, the scaffolding provided by the more knowledgeable person is progressively withdrawn. Finally, the learner is able to complete the task or master the concept independently. Akani (2015) in a related study revealed that there is a significant difference in the mean scores of students exposed to scaffolding instructional strategy and conventional method of instruction.

Studies have also indicated that educational networking has a profound positive influence on students' performance in Biology. In a related study, Nee (2014) found that using the educational networking as integration in the teaching of biology has a positive effect on secondary school students. From the results of the group experiments, it has been proved that the learning achieved by the experimental group is higher than that of the control group. The experimental group that applied the educational network as integration in biology teaching achieved better learning than their control-group counterpart that applied merely traditional face-to-face teaching. In other words, the educational network presented here is helpful in improving the achievement of biology learning among secondary school students. However, there are some factors found out to be responsible for the differences of the achievement test between the two groups:

Educational Networking is a platform for communication, collaboration and sharing of learning resources and knowledge. Slow learners and introvert students sometimes open up. Educators have widely acknowledged the value of community building and social interaction with and among students, in both face-to-face and online classes (Palloff & Pratt, 2007).

Beach & Doerr - Stevens (2011) confirms the possibility that social networking sites can have a positive effect on student achievement, stating that the nature of collaborative social networking sites can have a positive effect on the development of civic engagement among students. By the scenario of simulation and teaching activities, students can really achieve the purpose of entertainment. Furthermore, this educational network used a variety of Web 2.0 tools to communicate and interact, collaborate on projects in a safe environment and create and develop new perspectives in the study. Education network will improve the efficiency and quality of student collaboration. They will have a better meeting of communication and the ability to share information quickly and learn to work in teams.

Influence of Gender difference on Curiosity and Motivation

A strong background of science can help a nation grow socially and economically; thus, many countries are giving impetus to science at the school levels. In Africa, governments of many countries are coming up with policies to encourage students to participate in the field of healthcare, engineering, pure science, medicine, and other science-based courses (Saleh, 2014).

The future of African continent depends upon the full utilization of the human capital available to us; and women account for half of its population. Throughout the world, and particularly in Africa, there is a stark under-representation of women in Science, Technology, Engineering and Mathematics (STEM) professions. The leaky pipeline of women and girls begins as they start and progress through their schooling and enter into science and technology-based careers. According to UNESCO estimates, only 30% of researchers in sub-Saharan Africa are women, with the gender gap especially apparent in disciplines such as mathematics, engineering and computer science. Studies also indicate that women in STEM are paid less, publish less and do not progress as far in their careers compared to their male counterparts. This is a loss for the science, technology and innovation field and for society (Muhoro, 2020).

A country’s ability to secure good health, fight diseases, protect the environment, attain food sufficiency, and develop new industries and technologies relies on the scientific knowledge and skills of its people. To achieve this, it is expected that countries create, apply and diffuse scientific and technological knowledge. Unfortunately, many countries are not fully utilizing the potential of the entire population, including girls and women. Africa in particular continues to lag behind in many fields; in addition, women still make up a minority of the world’s workforce in STEM. For example, in 121 countries with available data, women make up 29 percent of science researchers. Globally, men outnumbered women as students, educators, researchers, and workers in STEM fields, yet women scientists have an important role to play in Africa’s development, including pushing the envelope on gender equality, one of the 17 Sustainable Development Goals (SDGs).

The Nigerian education system recognizes the vital role of STEM Education in achieving sustainable growth and development. This is evidenced by government’s commitment to ensuring that learning outcomes emphasize STEM skill acquisition at all levels of the educational system. The National Policy on Education (FRN, 2004) stipulates the compulsory teaching and learning of Mathematics, Basic Science and Basic Technology, computer education, and agricultural science among other subjects for the first nine years of compulsory schooling. For the 3 years of senior secondary schooling, students are expected to be taught Mathematics, Biology, Chemistry, Physics, Agricultural Science, Applied Electricity, Electronics, Technical Drawing, Computer Education, Auto mechanics, Food Science and Nutrition, Health Science, Building Construction amongst other subjects. At the tertiary level, the policy specifies that a greater proportion of expenditure shall be devoted to science and technology; the admission ratio into technology and business courses shall be weighed in the ratio of 70:30, and that 60% of admissions into conventional universities shall be allocated to STEM oriented courses, while at least 80% of admissions into universities of technology shall be allotted to STEM-oriented disciplines. Despite the NPE (FRN 2004) specification that every Nigerian Child shall have a right to equal educational opportunities irrespective of any real or imagined disabilities; each according to his or her ability, gender differences in enrolment in STEM careers show a lot of disparity, with females being underrepresented (Abe 2012; Salman, Olawoye, & Yahaya 2011).

UNESCO (2009) and Abe (2012) report that at the primary school level, enrolment of boys and girls are almost equal, except in Northeast and Northwest zones. However, the population of girls gradually dwindles with progression through the educational ladder (Danjuma 2010, Abe 2012). This gap is most worrisome considering the demographic dynamics of Nigeria's population. As at 2012, Nigeria's population stood at 166.2 million. It is currently estimated to be 178.5million with a ratio of 1:4 males to females (World Population Review 2014). The 2011 Global Gender Gap Report of the World Economic Forum ranked Nigeria 120 out of 135 nations in Gender Gap index. Gender gap refers to the differences between women and men, especially as reflected in social, political, intellectual, cultural or economic attainments or attitudes. Furthermore, Research reports indicate apparent differences in the curriculum choices made by boys and girls. These differences result in consistent under-representation of girls and women in science and scientific careers (Hill, Corbett and St Rose, 2010). From the opinion of Alade (2012), there is a wide disparity in enrolment and academic achievement of boys and girls in some areas of specialization. Female students tend to drift or be guided towards areas of studies regarded as feminine and thus shy away from scientific and technological fields. Furthermore, students' enrolment in the 2004 Senior School Certificate Examination indicates a disparity in male and female students' enrolment in science and technology inclined subjects. Nnaka & Anaekwe (2006), revealed that at the secondary school level, males prefer technical subjects while female enrolment was skewed towards home science.

A country is recognized as a superpower when it acquires the status of a scientific superpower. This can only happen when the younger generation is motivated to study science. However, according to a report on gender equality in the knowledge society, women representation in science and technology jobs has been the lowest for India, even though it ranks high on female enrolment in science and engineering courses (Study, 2013). Indian society has its own social norms and certain underlying rules for women and their roles in society that causes hurdles for women pursuing science both as an educational aim and as career (Kumar, 2016; Masoodi, 2016). The enrolment of women in education in India is largely decided by the patriarchal system of society that stereotypes women and expects them to abide by the same negative thought process (that women are typically home keepers meant to rear children and stay at home taking care of families, that cuts across a huge cross section of the country (Kumar, 2009). Countries like India, UK, France and the USA have shown a steady slump in women representation in Physics (Kurup, Maithreyi, Kantharaju, & Godbole, 2010). Since science is very important for societal growth, it is important that women also are equally motivated to pursue science and contribute to the nation's growth. Although female enrollment in STEM (Science, technology, Engineering and mathematics) related courses has risen over a period of time, there still does not seem to be a proportional rise in their representation in these fields (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011).

Gender differences in achievement have been widely reported. Gender is one of the personal variables related to differences found in motivational functioning and in self-regulated learning.

Over the years, much of the literature has supported the difference in attitudes in science learning that are influenced by school level and gender levels, where high-categorical schools show better attitudes than low-categorical schools level. In scientific studies, during the last decade, in math and science lessons gender differences have decreased, although, male students still have good attitude skills than female students. Male students in high schools take training in math and science lessons aimed at exploring their abilities. In addition, there are other studies that also address the major differences between the number of boys and girls who pursue their careers in science, math, and engineering. For instance, gender differences in mathematics performance has been attributed to various factors like an inborn difference in spatial ability, brain development, hormonal impact as well as societal stereotyping of females (for review, see: Ardila, Rosselli, Matute, & Inozemtseva, 2011; Spencer, Steele, & Quinn, 1998). Some previous studies have suggested that there is a difference in gender with regards to science motivation. Male students are in general found to be more interested in physical sciences like physics, chemistry and mathematics, while their female counterparts incline towards biological sciences (Alexander, Kuppam, Shaik Kadir, & See, 2010). And in another study that investigated the influence of students' motivational beliefs (learning goal orientation, task value and self-efficacy) in science learning on students' self-regulation, it was found that the influence of task value on self-regulation was statistically significant for boys only (Velayutham, Aldridge, & Fraser, 2012). In another study on a sample of 600 intermediate science students from Pakistan, it was seen that there is no difference between males and females as far as science motivation was concerned (Mubeen, Saeed, & Arif, 2013). In a study on self-regulated learning among 185 Malaysian science students, it was seen that girls exhibited a higher self-regulated learning than boys (Saad, Tek, & Bahrom, 2009). In another study by Iyer (2017), a significant difference in the components of grade motivation and intrinsic motivation between female and male students was observed.

Based on the discourse above, this present study is interested in finding the effect of an App enriched with CTCA on the Epistemic Curiosity of Biology Students.

Research Questions

1. Will there be any statistically significant difference in the epistemic curiosity of biology students taught nitrogen cycle using an app enriched with CTCA and lecture method?

2. Will there be any statistically significant difference in the epistemic curiosity of male and female biology students taught nitrogen cycle using an app enriched with CTCA and lecture method?

***Null Hypotheses*:**

Ho_1: There will be no statistically significant difference in the epistemic curiosity of biology students taught using an app enriched with CTCA and lecture method.

Ho_2: There will be no statistically significant difference in the epistemic curiosity of male and female biology students taught using an app enriched with CTCA and lecture method?

Materials and Method

Design: The quasi-experimental (pre-test, post-test non-equivalent group design) research design was employed. A quantitative method of data-gathering was used.

Subjects:154 senior secondary two biology students from four senior secondary schools in Ogun state, Nigeria, were involved. This class of students was considered appropriate for this study because they already learnt nutrients in their previous class which is a prerequisite for this study. Also, the class year of the students was considered appropriate as they were able to engage in abstract thinking regarding Piaget's theory. The subjects were 68 boys, 86 girls) ranged in age between 12 and 16 years, with a mean age of I4 years.

Instrument: The Biology Students' Curiosity Rating Scale was developed and was administered to both the experimental and control groups, before and after the treatment as pretest and posttest. This instrument was used to check if the treatment was effective in developing the curiosity of the students in Learning Biology. The rating scale also have two sections; A and B. Section A was used to gather demographic data of the students while section B contained 31 items in a four-point rating scale of: No curiosity(NS), Less curiosity (LS), Moderate Curiosity(MS) and Very High Curiosity (VHC). Two intact classes were assigned to the experimental groups. The group was further divided based on the location of school as rural and urban schools, on the other hand, the control group is also made up of two schools divided on the basis of rural and urban schools.

Both experimental and control classes were subjected to pre-test and post-test using the same curiosity rating scale.

In order to determine the reliability of the instruments, they were administered to 46 students that were not part of the sample for the study and the data was subjected to Cronbach's alpha using IBM-SPSS version 23. The Cronbach's Alpha value yielded 0.72 and is therefore considered reliable. Finally, data on this study were subjected to ANCOVA using IBM-SPSS version 23.

Table 1: Reliability Statistics

Cronbach's Alpha	N of Items
.715	31

Table 1: Output of Cronbach's Alpha on Students' Curiosity

<u>Ethical considerations</u>

Before the commencement of the study, the consent of relevant authorities of the schools (principals of public schools) involved in our study was sought for permission to carry out the study in their schools. Also, the research team ensured that all participants willingly took part in the study. The study's objectives were fully communicated to the participants while they were assured that their responses were treated as confidential and used only for research purposes. Apart from the above, no injury or harm was recorded in the course of this study.

<u>Results</u>

Research Question1: Will there be any statistically significant difference in the epistemic curiosity of biology students taught nitrogen cycle using an app enriched with CTCA and lecture method?

Ho_1: There will be no statistically significant difference in the epistemic curiosity of biology students taught nitrogen cycle using an app enriched with CTCA and lecture method?

<u>Table 1: Levene's Test of Equality of Error of Variances</u>

F	df1	df2	Sig.
3.175	1	152	0.77

Table 2 above revealed that data satisfied the assumption of homogeneity of variance {F = 3.175; p > 0.05.

Table 2: Descriptive Statistics

Instructional Strategy	Mean	Std. Deviation	N
CTCA	3.3465	.27425	68
Lecture method	3.1423	.50950	86
Total	3.2325	.43301	154

Table 2 above revealed that data the experimental group had a mean of 3.3467, while the control group had a mean of 3.1423.

Table 3: Analysis of Covariance on the Post-test Epistemic Curiosity based on Instructional Strategy

Source	Type III Sum of Squares	df	Mean square	F	Sig.
Corrected Model	6.152a	2	3.076	20.613	.000
Intercept	37.771	1	37.771	253.097	.000
Pretest Curiosity	4.570	1	4.570	30.621	.000
Instructional strategy	2.360	1	2.360	15.817	.000
Error	22.535	151	.149		
Total	1637.809	154			
Corrected Total	28.687	153			

When analysis of covariance was applied to students' epistemic curiosity with the pretest scores as the covariate. The ancova results showed that biology students taught using Aladeokin's 1.0 biology app enriched with CTCA demonstrated a superior performance over the lecture method group {(1,151) = 0.000; p <.05}.

Decision

The null hypothesis that states that there will not be any statistically significant difference in the epistemic curiosity of biology students taught Nitrogen cycle using an app enriched with CTCA and lecture method was rejected.

Research Question Two: Will there be any statistically significant difference in the epistemic curiosity of male and female biology students taught nitrogen cycle using an app enriched with CTCA and lecture method?

Ho$_2$: There will be no statistically significant difference in the epistemic curiosity of biology students taught nitrogen cycle using an app enriched with CTCA and lecture method?

Table 4: Descriptive Statistics
Dependent Variable: Posttest Curiosity

Gender	Mean	Std. Deviation	N
Boys	3.2195	.39197	61
Girls	3.2410	.45981	93
Total	3.2325	.43301	154

Table 4 above revealed that male biology students had a mean of 3.2195, while the female biology students had a mean of 3.2410.

Table 5: Levene's Test of Equality of Error Variances
Dependent Variable: Posttest Curiosity

F	df1	df2	Sig.
1.772	1	152	.185

Table 2 above revealed that data satisfied the assumption of homogeneity of variance {F = 1.772; p > 0.05.

Table 6: Analysis of Covariance on the Post-test Epistemic Curiosity based on Instructional strategy and Gender

Source	Type III Sum of Squares	df	Mean square	F	Sig.
Corrected Model	3.797	2	1.898	11.516	.000
Intercept	40.316	1	40.316	244.581	.000
Pretest Curiosity	3.780	1	3.780	22.930	.000
Gender	.005	1	.005	.029	.866
Error	24.890	151	.165		
Total	1637.809	154			
Corrected Total	28.687	153			

When analysis of covariance was applied to students' epistemic curiosity with the pretest scores as the covariate. The ancova results showed that both male and female biology students taught nitrogen cycle using an app enriched with CTCA did not demonstrate any superiority over each other in their performances. {(1,151) = 0.866; p >05}.

Decision

The null hypothesis that states that there will not be any statistically significant difference in the epistemic curiosity of male and female biology students taught Nitrogen cycle using an app enriched with CTCA and lecture method was rejected.

Discussion

Effect of Treatment on Epistemic Curiosity of Biology Students Taught Nitrogen Cycle.

Data analysis from the study gave a sufficient support for the efficacy and effectiveness of the treatment. The experimental group which was taught using Aladeokin's 1.0 biology app enriched with the elements of culture, technology and context had a stronger epistemic curiosity.
[F (1,151) =0.000; P< 0.05] as reported in table 3.

The results of data analysis revealed a statistical significant difference in the epistemic curiosity of biology students. One fact about the benefit of CTCA to students' learning is that it promotes scientific literacy of the students.

Based on the epistemic curiosity measure, this finding is in agreement with results of previous studies on effect of treatment on students' achievements in Biology and epistemic curiosity. Kind and Osborne (2016) opined that, as science is the basis of our culture, everyone should have both basic conceptual knowledge as well as an understanding of how this knowledge was derived. This was also buttressed by Okebukola (1990), who confirmed that meaningful learning involves understanding how all the pieces of an entire concept fit together. The knowledge gained through meaningful learning applies to new learning situations. This type of learning stays with students for a long time (for life).

Meaningful learning is active, constructive, and long lasting, but most importantly, it allows students to be fully engaged in the learning process. In the light of these assertions, one important scientific attitude that can help students learn meaningfully is curiosity. This is an "innate love of learning and of knowledge without the lure of any profit"

The result of this study implies that the use of the app helped students to develop the desire to learn. Among several other adaptive outcomes, curiosity is believed to have contributed to the development of intelligence, wisdom, happiness, meaning in life, tolerance to stress, satisfaction and engaging social relationships (Kashdan, 2009; Silvia, 2006).

The overall importance of epistemic curiosity to science students is the development of scientific literacy, because the present spate of development in the world and advancement in scientific research are the products of human curiosity. According to Stanat et al. (2002), in their opinion asserted that scientific literacy comprises an understanding of fundamental scientific concepts and familiarity with scientific ways of thinking and working, and the ability to apply this knowledge of scientific concepts and processes, particularly to evaluate aspects of science and technology. It also requires the ability to identify questions that can be answered by scientific inquiry and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and changes made to it through human activity.

Scientific literacy stands for what the general public ought to know about science and commonly implies an appreciation of the nature, aims, and general limitations of science, coupled with some understanding of the more important scientific ideas. The term is usually regarded as being synonymous with 'public understanding of science and, although the concept is for various reasons often regarded as controversial, the notion of scientific literacy is now commonly acknowledged to consist of three dimensions:

1. An understanding of the norms and methods of science
2. An understanding of key scientific terms and concepts
3. An appreciation of the impact of science and technology on society.

The findings in this study is in agreement with Berlyne (1978), Loewy (1998), they see curiosity as the desire and preparedness to receive new information and experiences, this is one of the steps in CTCA. The study also agrees with Litman & Silvia (2006), these authors posited that it is the basis for an exploring behavior.

Effect of Treatment on Epistemic Curiosity of Male and Female Biology Students Taught Nitrogen Cycle.

Data analysis from the study gave a sufficient support for the efficacy and effectiveness of the treatment. The experimental group which was taught using the app enriched with the elements of culture, technology and context had a stronger epistemic curiosity.
[$F(1,151) = 0.866$; $P > 0.05$] as reported in table 6.

The results of data analysis revealed there was no statistical significant difference in the epistemic curiosity of male and female biology students. Result from this data analysis is in agreement with the National Policy on Education (FRN, 2004) which stipulates the compulsory teaching and learning of Mathematics, Basic Science and Basic Technology, computer education, and agricultural science among other subjects for the first nine years of compulsory schooling. For the 3 years of senior secondary schooling, students are expected to be taught Mathematics, Biology, Chemistry, Physics, Agricultural Science, Applied Electricity, Electronics, Technical Drawing, Computer Education, Auto mechanics, Food Science and Nutrition, Health Science, Building Construction amongst other subjects. This is because everyone is important to the success of scientific and technological advancement in Africa, and the fact that every Nigerian Child have a right to equal educational opportunities irrespective of any real or imagined disabilities, ability and gender. The result of this study is also in agreement with Mubeen, Saeed, & Arif (2013), in which it was seen that there is no difference between males and females as far as science motivation was concerned. However, the result is at variance with Nnaka & Anaekwe (2006), which revealed that at the secondary school level, males prefer technical subjects while female enrolment was skewed towards home science. Also, the result negates Velayutham, Aldridge, & Fraser (2012), who investigated the influence of students' motivational beliefs (learning goal orientation, task value and self-efficacy) in science learning on students' self-regulation; it was found that the influence of task value on self-regulation was statistically significant for boys only.

In conclusion, data analyses and results from this study have sufficiently established the potency of the app enriched with elements of culture and context to promote students' epistemic curiosity. This study suggests and encourage teachers to make use of students' culture, context and technology to mitigate against several of misconceptions about science and technology education among female students. Furthermore, the brick walls created by gender stereotyping in science and technology has been demolished.

Implication of the Study

The implications of these findings are that:

1. The location of the school as a barrier has been completely removed. Students in the experimental group who are from the rural environment were able to relate with the topic using cassava fermentation as a cultural practice in their local environment to explain how the nitrogen triple bond is broken with help of bacteria.
2. The assumption that science and technology is a male adventure has been negated also, this implies that both male and female students can learn meaningfully by using the app.
3. Students' curiosity was boosted, thereby encouraging them to attempt their assignments and submitting them promptly.

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No potential conflict of interest was reported by the author(s).

Conflict of Interest

No potential conflict of Interest was reported by the authors.
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Direction for further studies

We intend to find the perception of biology students about the use of the app

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