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RESEARCH ARTICLE

WAYS TO LEARNING SCIENCE ARE UNDERGOING MUTATION: WOULD THE CULTURO-TECHNO-CONTEXTUAL APPROACH BE AN EFFECTIVE VARIANT FOR LEARNING CHEMISTRY?

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Abstract

As the quest for better ways to present science to the new generation of students continues to occupy the thoughts of science educators across the globe, so will new approaches such as the Culturo-Techno-Contextual Approach (CTCA) continue to emerge in response to thisquest. This study explores the potency of CTCA in breaking the barriers to meaningful learning of electrochemistry. The explanatory sequential design was employed. A total of 141 secondary school (II) students from two purposively selected schools in Lagos State education district V participated in the study. The electrochemistry achievement test which had a reliability coefficient of 0.78 was the instrument used to collect the quantitative data. Treatment lasted five weeks after the conduct of the pretest, the experimental group was taught using CTCA and the control group was taught using the traditional lecture method. Four weeks after the posttest, the retention test was conducted. One-way ANCOVA wasused to analyse the data. The experimental group outperformed the control group, but CTCA had no differential impact on students in the experimental group based on gender. Within the limitations of the study, we concluded that CTCA is capable of promoting meaningful learning in chemistry. Implications of the study were highlighted.

Introduction:-

Science education communities around the world witnessed incredible advancements in science teaching and learning in the 20th century as research outputs focused largely on how to improve students' performance (Abanikanda, 2019; Sannu, 2015; Oludipe, 2012); and winning more students to science (Afuwape and Olugbuyi, 2019; Aikenhead and Ogawa, 2007). By the dawn of the century and since the beginning of the 21st century, there has been a slight shift in the thrust of science education research and advocacy towards promoting unity and inclusion for global scientific literacy (Oladejo et al., 2022). This growing call for inclusiveness at all levels of

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science teaching and learning (including informal science) has taken different shapes and dimensions to include respect for different worldviews about science (Martínez, 2020), early science learning (Ikpah, 2022) and STEM-E (Tunnicliff, 2022), and emerging methodologies for delivering school science (Okebukola et al., 2016).

Focusing on emerging methodologies, as science educators, particularly within the walls of the classroom, how do we teach science to our new generation of students and how should we? Several studies (Adesope and Nesbit, 2013; Bamidele and Ogunleye, 2017; Bankole, 2018) have affirmed the effects of teacher's choice of teaching approach on students' interest and achievement in science especially at the secondary school level. At this level, in Nigeria and most part of Africa, the teacher remains the centerpiece of information on subjects' contents and serves as the major determinant of the quantity and quality of learning that the students enjoy. This is one reasonthe majority of research in Africa for over two decades on how to better students' performance in science and reverse the fast-declining rate of students' choice of science, have focused on approaches that science teachers can employ to change this narrative, but sadly, no significant improvement has been recorded (Dansu, 2022).

In finding lasting solutions therefore, and in pursuance of the 'Africa we want' as detailed in the AU's agenda 2063, we must rethink how we convey the 'science story' to our students in the classroom. In doing so, we must keep in mind that these students are very sensitive, ask questions at will, filter whatever information that is passed to them, and they do not like to learn the ways their predecessors learnt (Akinola, 2014).However, recognising these characteristic differences is easy but providing appropriate approaches that can meet the needs of the students and surpass the limitations of the older methods of teaching science in our schools is more tasking and deserves our rapt attention. In most parts of Africa, science learning at the senior secondary school level is delineated into three major subjects: biology, chemistry, and physics. Our choice of chemistry in the study was pricked by the persistent unimpressive performance of the students in the last ten years (Ademola, 2020; Oladejo et al., 2022) and the possible effect that the students' understanding of chemistry plays in the learning of the two other subjects (biology and physics). For instance, the periodic table and its related topics such as compounds, metals, and non-metals, are mainly taught in chemistry in our schools given the dictates of the curriculum. However, the information is essential and serves as requisite knowledge in learning some science concepts in biology (nutrient cycle) and physics (gas laws, radioactivity).

To this end, the need to enhance students' meaningful learning of chemistry has received considerable attention from concerned individusls and bodies across the country. In the last ten years, this attention has been more pronounced through search for concepts that students find difficult to learn in chemistry (Agogo and Onda, 2014; Uzezi, Ezekiel & Auwal, 2017), and how to ease the difficulties because according to Okebukola (2021), it is these concepts that students find difficulties with in each of the science subjects that deter them from learning science. In a report of survey of students' view (through interview) on why they find certain concepts in chemistry difficult to learn, Ademola (2020), noted that the most preponderant responses border around the methods of teaching used by the teachers and the abstractness of chemistry concepts. This perception creates some level of fear in the students, distorts their interest in learning when the subject chemistry is mentioned and thus, impacts their performance negatively.

In an earlier study, Oladejo et al. (2021) noted that content-context disconnect is one major problem facing the delivery of STEM subjects in our classrooms, particularly at the senior school level. Students learn and forget easily, and most teachers rarely ask why. Studies have shown that one main reason students do not remember most of what they learn in the science classroom is because of the manner by which the contents were presented (Akinola, 2014; Okebukola et al., 2016; Onowugbeda et al., 2022). We teach science, particularly chemistry, like it is all abstract and far away from the reach of the students. In the chemistry classroom, teachers speak of atoms, elements, and molecules like someday soon, they will fall from the sky for the students to see.

The teacher's poor knowledge of the chemistry around him/her is reflected in the manner by which he/she presents the content to the students. To teach sulphur and its compound to a group of students in any school within the local community in Lagos or Ogun state (South-western part of Nigeria), why should the teacher not relate the topic to any local herb sellers "eleweomo" around the school where the students can find "efinimiojo pupa" usually bright yellow in colour – sulphur? The same goes for a biology or home economics teacher teaching skincare and could not relate camwood to the common "osun". Osun is commonly used by our fathers to treat and prevent skin problems particularly for babies and it goes by the saying "kii tan ninuigbaosunkamari fi pa omolara". When science contents are exemplified with what is available within the reach of the learners, it concretises learning (Adebayo et al., 2022;

Abdulhadi et al., 2022). While this observation may not be entirely new, it is of great concern to this study because the desired results in students' learning and understanding of chemistry concepts beyond memorisation and shallow comprehension are yet unattained.

However, we see a blink of hope in the new trends in literature (Sannu, 2015; Egerue; 2019; Dansu, 2022) that are suggestive of ways to attract students to live and love science and to sustain their interest. These trends focused on the power of the students' cultural background, locational context and relevance of technology in today's classroom. We summarized their collective submissions to mean that the new generation of students don't just want to learn science, they want to learn what they can see and relate with, in a relaxed and friendly atmosphere and with some fragrance of technology. It is against this background that this study tested the efficacy of the culturo-techno-contextual approach (CTCA) in promoting students' meaningful learning of electrochemistry, which in the last ten years, has remained on the list of concepts that students find difficult to learn (Uzezi& Deya, 2020; Oladejo et al., 2022).

Research questions:

(1) What impact has CTCA in improving students' achievement in electrochemistry; (2) Will CTCA have a differential impact on student's achievement based on gender? (3) What perception do students hold about CTCA in improving their learning of electrochemistry?

Model, Philosophy and Theoretical Frameworks

The culturo-techno-contextual approach (CTCA) emerged as a new variant of method of science teaching to address some of the recurring challenges to good science teaching and meaningful learning of science. This approach as shown in figure 1 is a presipitate of culture, technology, and context. It is an amalgam of (a) the cultural context in which learners are immersed; (b) technology-mediation to which teachers and learners are increasingly dependent; and (c) locational context which is the unique identity of every school, and which plays a strong role in the examples and local case studies for science lessons. CTCA emphasises cultural localisation as a basis for understanding science and promoting meaningful learning (Okebukola, 2021).

The universality nature of science depicts that science is present in every culture and the scientific knowledge of a people is usually embedded in their indigenous or cultural knowledge which expresses how they view the world, their understating of how the world works and how they utilise such understanding to better their existence and cater for their needs. Culture (indigenous knowledge) is one of the three components of the culturo-techno-contextual approach. In using CTCA in the classroom, students are made to connect every lesson to their indigenous knowledge or cultural practices, giving their ways of life a sense of relevance to what they are been taught in the science classroom and demystifying the contents. This understanding is deeply rooted in Nkrumah's ethnophilosophy, one of the philosophical bases of CTCA.Ethnophilosophy is the study of indigenous philosophical systems; it is based on the position that a specific culture (like that of the Igbo or Yoruba in Nigeria) can have a philosophy that is not applicable and accessible to all peoples and cultures in the world and at the same time have some commonalities with other cultures anywhere in the world.

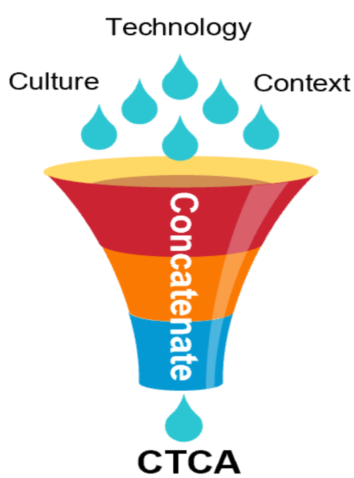

Fig 1:- The CTCA frameworks.

Vygotsky's theory of social constructivism provides a strong base for the implantation of CTCA. Before any lesson (usually, not less than two days), the students are informed of the topic to be learnt in class and are directed to do two things as preparatory activities: (1) visit the YouTube to watch any lesson video related to the topic/concepts to be learnt, (2) based on the information gained from the video, interact with parents or any adult on cultural practices or local knowledge related to the content. On getting to the classroom, the students are put into groups to share these findings among themselves. This way, the students learn from interactions with parents and through the YouTube videos – they serve as the more knowledgeable other (MKO) described by Vygotsky.Thus, CTCA rests on the proposition of Vygotsky's sociocultural theory which asserts that learning is essentiallya social process.

The mixed-sex, mixed-ability groupingwhich allows for peer interaction among the studentsas they engage in discussion of findings for the pre-lesson assignments support the assumptions of Vygotsky's scaffolding theory. The culturo-techno-contexual approach proports that through thepeer intraction, the students learn from one another, and as they do so, gradually, they move from their zone of can do without help to a higher zone of proximal development (ZPD) espoused by Vygotsky (1962; 1978). Another theory base for the study is Ausubel's theory of advance organiser. Ausubel (1963) proposed the notion of an advanced organiser as a way of helping students link their ideas with new material or concepts. These more inclusive concepts or ideas are advanced organisers (Ausubel, 1978). This connects with CTCA whose procedure demands that learners link ideas or find out the relationships among concepts using their prior knowledge of the subject matter (gained from the prelesson assignments) through mental scaffolding, to foster deep or meaningful learning.

Design and Procedures

This study employed explanatory sequential design. The quantitative phase was quasi-experimental, and the qualitative phase was an in-depth interview. Two schools located in different parts of Lagos State education district V were purposefully selected to prevent students in each group from interacting with one another. Our choice of the study area was prompted by the record of high failure rate of students in the major science subjects including chemistry and their general lack of interest in science (Ademola, 2020). The control group which had 72 subjects (39females and 33 males) was taught using the lecture method while the experimental group which had 69 subjects (38 females and 31 males) was taught using CTCA. Students in senior secondary school II (the equivalent of 11th grade) were considered appropriate because, by the structure of the syllabus and general school calendar, at the time the study was conducted, they had not been taught theelectrochemistry concepts treated in this study but had learnt the requisite concepts such as oxidation and reduction.

The mean age of the students was 14 years. The quantitative data was collected using the achievement test in electrochemistry (ATE). The instrument (multiple choice) had 30 district items, each item had three distractors and one key. The items were evenly distributed across the cognitive process dimension (Anderson and Krathwohl, 2001) and all items carried equal score weight. It was validated by a group of four experts in science education (chemistry option) with close to two decades of experience in science teaching and research. To strengthen the validity of the instrument, a pilot run was carried in a different school from the schools used for the study but within the same education district. Twenty-two senior secondary III students participated in the pilot test because they had already been taught electrochemistry.

At the completion of the test, we asked the students in general if there were questions that were unclear to them, we got three responses from three different students, although some other members of the class disagreed. The questions were read aloud in the class and the members of the class provided open answers to them. Based on that, we concluded that the difficulties were only peculiar to those students. The major modification that was made to the final draft of the instrument based on the pilot testing, was time allocation from 30 to 45 minutes. A reliability coefficient of 0.76 was obtained for the instrument using the split-half procedure. Before treatment, the experimental and control groups were subjected to pretest, the treatment lasted five weeks and each week, there was a teaching contact of 80 minutes in each group. In week one, the students were taught electrode potential and the concept of standard electrode potential. Week two featured electrochemical cells, in week three, we treated electrolysis (conceptual meaning and laws of Faraday) and calculations in electrolysis was the focus of week four while electroplating was the last topic. The control group was taught using the traditional lecture method while the experimental group was taught following the five-step procedure for implementing CTCA at every lesson (see www.ctcappraoch.com for further details).

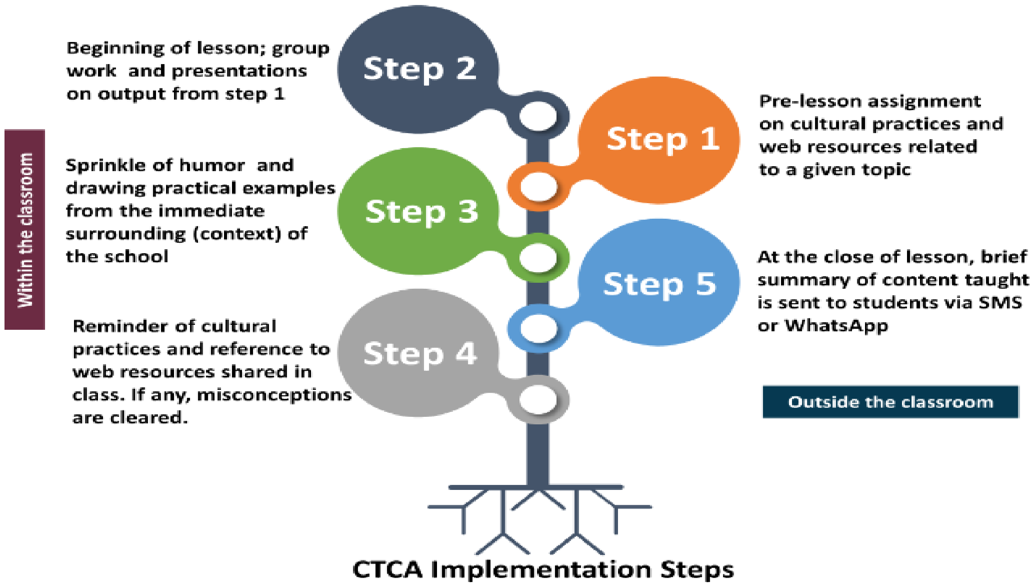

Fig. 2:- Classroom implementation of CTCA at a glance.

1. As pre-lesson activity, the teacher requested students ahead of time (three days ahead) of the topic to be learned in class (in one of the lessons, electrolysis) to (a) reflect on indigenous knowledge or cultural practices and beliefs associated with the topic or concept. 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 flavour of the approach).
2. At the start of the lesson and after the introduction by the teacher, students were grouped into mixed ability, mixed-sex groups (eight 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 each of the group leaders. The teacher wraped up by sharing his/her indigenous knowledge and cultural practices associated with the topic.
3. The teacher progressed the lesson, drawing practical examples from the immediate surroundings of the school. Such examples can be physically observed by students to make science (or any subject) real. This was the "context" flavours of the approach. The teacher sprinkles delivery with some content-specific humour.
4. As the lesson further progressed, the class was reminded of the relevance of the indigenous knowledge and cultural practices documented by the groups for meaningful understanding of the concepts. Misconceptions associated with cultural beliefs were cleared by the teacher.
5. At the close of the lesson, the teacher sent a summary of the lesson (usually not more than two pages of SMS, that is, about 350 characters) via WhatsApp to all students. After the first lesson, the group leaders were saddled with the responsibility of sending lesson summaries to the class through the WhatsApp platform for the class. This was another technologyflavour of the approach.

Some indigenous knowledge/cultural practices related to concepts in electrochemistry which were shared by students in the experimental group as part of learning experience are shown in figures 3 to 5. The groups were post tested after the treatment was over and 12 students randomly selected from the experimental group (6 males & 6 females) were interviewed on their perceived impact of theapproach on their learning of electrochemistry using the Students' Perception About CTCA Interview Guide. The students' consent to participate in the interview were sought following the permission from the school's authority. They were assured that there are no right or wrong answers to any of the questions and that whatever information they provide will be treated confidentially and used for academic purposes only.

Four weeks after the posttest a retention test (post-posttest) was conducted for the two groups without prior notice. This was to ascertain the degree to which the students were able to retain the information gained during the treatment phase. The qualitative data were analysed using structured coding (i.e., framework analysis) which afforded us a robust discussion of the results from the quantitative data.

Fig. 3:-Ayo olopon' and 'rote' (electrode potential).

Fig. 4:- The Battery charger (electrolysis).

Fig. 5:- The iron pot making and goldsmith (electroplating).

The credibility of qualitative data collected was ensured on two fronts: through participant triangulation and member check. Given the level of the participants in the study, the member check was done by giving the audio recordings and the transcription to two experts in qualitative studies to ascertain that our interpretations captured the interviewees' rendition.

Analyses and Results:-

Using IBM-SPSS version 23, we conducted preliminary tests of normality and homogeneity on the quantitative data. The data passed the Shapiro Wilk's test of normality for the control [(72) =.98; p>.05] and experimental groups [(69) = .97; p>.05]. The data also passed the Levene's test of equality of error variance (F=.23; p>.05) which indicated that the groups do not vary significantly from one another and hence, comparable. We therefore proceeded to analyse the data using the students' pretest and post-posttest scores. Since the subjects were not randomly assigned to groups, it was imperative that we employ analysis of covariance so as to partial-out the effect of any initial difference between the experimental and control groups which might confound the results from the data. This was achieved by factoring the pretest data into the one-way ANCOVA equation as covariate.

On research question one which sought a statistically significant difference in achievement between theexperimental and control groups, the result obtained showed that the experimental group (M=16.20) significantly [F(1,138)=198.34; p<.01] outperformed the control group (M=9.79), and that the teaching strategy used in the experimental group (CTCA) accounted for about 60% ($\eta_p^2 = .59$) of the performance rate of the group. This result is found to be consistent with the findings of Egerue, (2019) and Adeola, (2020) who found CTCAto be helpful in promoting meaningful learning of biology concepts.On research question two which sought a significant differential impact of CTCA on student's achievement based on gender, we found that there was no statistically significant difference in the performance of male (M=15.88) and female (M=16.35) students in the CTCA group [F(1,66)=.43; p=.51], although, the female students had a higher mean score. This result tallies with those of Abdulhadi et al., (2021) and Adebayo et al. (2021).

The summary of our findings on the third research question shows that the students consider CTCA a better approach to learning chemistry and they also confirmed to us that it aided their understanding of the electrochemistry concepts taught in class. Notably, majority of the interviewees considered the cultural knowledge, the YouTube videos, and class group activities as the most impactful aspects of theapproach when asked during the interview that "which aspect of the approach did you find most interesting and helpful in your understanding of the topics and why? Is it the YouTube videos; the related cultural/indigenous practice; or the type of examples cited by the teacher?"

Students' Id	Raw (unedited) students' response
Student A, Female, 14 years	Sir, I found the group activities most interesting because sometimes I could not watch the lesson videos from YouTube, hearing from my classmates really helped me to catch-up. I also love the jokes from the teacher.
Student B, Female, 15 years	The most interesting part of the lessons for me is the cultural knowledge. I found it interesting to know that our culture is related to chemistry that we always think is abstract and difficult to learn.
Student C, Male, 15 years	Sir, I was made a group leader but initially, I was afraid to face the class because I have never presented in class before. So, I always watch lesson videos from YouTube and discuss with my mum to make sure my group perform very well. I wish other teachers too can use this method.
Student D, Female, 14 years	Sir, I like the method. It makes the lesson lively and for me, I really enjoy the group discussion because I learnt many things from my friends.
Student E, Male, 15 years	What I enjoyed most was the culture knowledge. My mum was the one who always assist me with the cultural knowledge, and I was always happy to share with my mate during our group discussion.
Student F, Male, 14 years	I would say the cultural knowledge is theaspect of the method I found most interesting, and which helped me to learn better because I was able to relate the topic like electrolysis to what we do at home. I also enjoyed the group activity because I learnt from my friends.

Table 1:- Responses from selected students on their perceptions about CTCA.

Discussion of Results:-

There are several interpretations for these results, from our lenses, we viewed the success story of CTCA in the current study as resulting from four directions. The pre-lesson assignments that were given to the experimental group before each lesson was taught. By this, students in the CTCA group came to class prepared, having learnt from parents and/or YouTube. The positive impact of interacting with a more knowledgeable other (MKO) and use of advancedorganiser on learning as espoused by Vygotsky and Ausubel appear to have manifested in the students' performance.From the students submission, we conjected that while the online videos would have contributed greatly to the students leaning through the visual and auditory senses (Amoo, 2009; Oladejo and Ebisin, 2021), the most active agent in the pre-lesson assignment could have been the cultural context in which learners are immersed; as explained in the treatment procedure, in implementing the "culturo" part of CTCA, the teacher asked students to document indigenous knowledge or cultural practices related to the topics that were treated. In carrying out this task, students were able to see that their indigenous knowledge and cultural practices do not count for naught. This aspect of CTCA helped students to connect every lesson to their indigenous knowledge or cultural practices, giving their ways of life a sense of relevance to what they are been taught in the science classroom and demystifying the contents. This understanding is deeply rooted in Nkrumah's ethnophilosophy, one of the philosophical bases of CTCA.

The group discussions may also have played an important role since students are said to learn easily and without fear from one another (Okebukola et al., 2016). As noted by Adebayo et al., (2022) and Okebukola, (2021) when students are scaffolded, they do not only share knowledge among themselves, but they also radiate the team spirit which affords the notvery academically sound students to move with their colleagues from their zone of can do without help to higher learning zone of proximal development (ZPD). This ZPD is what Vygotsky defined "as the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Okebukola, 2021). At this stage, the old saying that 'iron sharpens iron' was already at play in the CTCA group which may not be readily available in the control group. Thus, collaboration rather than unhealthy competition, was consciously put in place to facilitate meaningful learning.

Overall, from instructional scaffolding to mental scaffolding, what is obvious is that the culturo-techno-contextual approach presents the students with multiple opportunities to learn including through the summaries of lessons which were presented to the students via the class WhatsApp platform. Several studies have confirmed the effects of multiple learning opportunities on students' achievement in science. Students who rely just on the teacher as the only source of information may not do well as much as their colleagues with access to multiple avenues to learn (Onowugbeda et al., 2022; Hwang & Ham, 2021; Rüller et al., 2022; Urick et al., 2018).

Closing the gender gap in students' performance in science particularly in chemistry has been a major area of attention among science education researchers (Nzewi, 2020). In this study, we found a similar trend of result with previous works on CTCA that have reported no significant difference between the male and female students. Given the difference in the parameters of these previous studies (from choice of STEM subject and topics treated to location of study, sample size andclass year) and the current one, we are beginning to hypothesis that the similarity in the findings of these studies is likely beyond mere coincidence. It appears that there is an active agent in the culturo-techno-contextual approach that supports the nature and leaning preferences of the girl-child.

We noted three possible action mechanisms that could have accounted for this result; the sourcing of related indigenous knowledge; the classroom atmosphere and interaction; and the repeated information. When students were asked to source for indigenous knowledge or cultural knowledge related to the concept to be learnt in class, the closet source of this information to the students were the mothers and elder sisters.During the interview and class sessions, most students confirmed to have fetched their answers from their mothers, by this, the female students have equal opportunityto gain the required information as much as the males if not a better chance given the natural closeness of the girl-child to the mother (Oludipe, 2012). According to Nzewi (2020), a learning environment that promotes collaboration and active students' participation (mixed-sex, mixed-ability grouping – CTCA step 2) hepls the female students tolearn better. Nzewi also noted such an environment should be free from boredom or filled excitement. This is another opportunity that CTCA offers through the content-specific humour that the teacher shared in step 4 and which may have favoured the female students.

Conclusions:-

The primary focus of this study which is to promote chemistry teaching and learning in Nigeria resonates the need for Africa as a continent to not relent in its quest to move-up the lather in the international STEM space. Currently, many African counties are within the lower rungs of league tables (Onowugbeda et al., 2022), thus, there is an urgent need to address this challenge if the goals of the AU's Agenda 2063 (The Africa We Want), pillared on quality science and technology education, is to be met. In seeking ways out, we must continue to remember that culture and context play significant roles in student learning. The one-size-fits all model is no longer dependable and we must begin to culturally immerse and contextually situate our approaches to science teaching and learning. This is the undergirding principle of the culturo-techno-contextual approach (CTCA) that was experimented in this study.

Based on the findings of this study, we have demonstrated that the narratives of Nigerian students' performance in STEM subjectssuch as chemistry and in other African countries can be rewritten. In spite of the limitations of the study given its scope and sample size, its findings are useful additions to the theoretical construct of socio-cultural learning as espoused by Vygotsky (1978) and Okebukola (2021). This study, therefore, presents CTCA to chemistry teachers in search of evidence-based culturally relevant pedagogy for promoting meaningful learning among secondary school students. Our findings also showcase CTCA as a value pack for promoting science identity, decolonizing science teaching and learning, and for bridging the existing equity gap and access to quality science learning.

Thus, beyond the confluence of Africa, we note that insights from this study align with the aspirations of leading global STEM education communities which border around improving science education through research. To this end, professional science educators whose research interest rover around equity and sociocultural issues will find this study to be of great value (replicability and relatability). Given the advocacy of science education communities across all regions on inclusivenessand equityas the effects of the 2020 pandemic gradually ease-off, one would want to ask that what is more inviting and uniting in a learmingcommunity than a tool that fades out common lines of differences and says “I am because we are” as is, in the humanizing and egalitarian characteristics of the culturo-techno-contextual approach.

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References:-

1. Abanikannda, M. O. (2019). Effectiveness of hypermedia and multimedia learning strategies on the academic performance of chemistry students in Nigeria. Labor et Educatio, (7), 201-214.
2. Abdulhadi, M. P., Okebukola, P.A., Awaah, F., Oladejo, A. I., &Agbanimu D. (2022, March 27-30). Will CTCA Help Students' Understanding of Difficult Concepts in Computer Studies? [Paper presentation]. NARST 95th Annual International Conference: Unity and Inclusion for Global Scientific Literacy: Invite as a Community. Unite as a Community, Vancouver, British Columbia.
3. Adebayo, I., Oladejo, A. I., Okebukola, P.A. (2022, March 27-30). Examining the Relative Effectiveness of CTCA in Improving Secondary School Students' Achievement in Genetics [Paper presentation]. NARST 95th Annual International Conference: Unity and Inclusion for Global Scientific Literacy: Invite as a Community. Unite as a Community, Vancouver, British Columbia.
4. Ademola, I. A., (2020). Nuclear Chemistry as a Difficult Topic for Secondary School Students: Harnessing the Power of Indigenous (Cultural) Knowledge for its Understanding. In P. A. Okebukola (Ed), Breaking Barriers to Learning: The Culturo Techno-Contextual Approach (CTCA) (pp. 252-261). Sterling Publishers.
5. Adeola, R. L. (2020). Exploring the Efficacy of the Culturo-Techno-Contextual Approach (CTCA) in Improving Achievement of Secondary School Students in Adaptation. Breaking barriers to learning of science: The CTC Approach. Slough UK: Sterling Press.
6. Adesope, O. O., & Nesbit, J. C. (2013). Learning with animated and static concept maps. Learning and Instruction, 27, 1-10.
7. African Union Commission. 2015. “Agenda2063 Report of the Commission on the African Union Agenda 2063 the Africa We Want in 2063.” Final ed. https://au.int/en/agenda2063/overview
8. Afuwape, M. O., &Olugbuyi, A. L. (2019). Eradicating Poor Achievement in Basic Science and Technology through Learning Activity Package: How Do Students Behave in Nigeria? Journal of Education in Black Sea Region, 5(1), 15-25.
9. Agogo, P. O.; Onda, M. O. Identification of students perceived difficult concepts in senior secondary school chemistry in Oju local Government area of Benue State, Nigeria. Global Educational Research Journal 2014, 2 (4), 44−49.
10. Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. Cultural Studies of Science Education, 2(3), 539-620.
11. Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. Cultural Studies of Science Education, 2(3), 539-620.
12. Akinola V. O. (2014) Learning Style, Information and Communication Technology – Activities and Achievement in Biology [PhD thesis], Lagos State University, Ojo, Nigeria
13. Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. Longman.
14. Ausubel, D. (1963). The psychology of meaningful verbal learning. New York: Grune & Stratton. Ausubel, D.
15. Ausubel, D. (1978). In defense of advance organizers: A reply to the critics. Review of Educational Research, 48, 251-257.
16. Bamidele, A. D., & Ogunleye, B. O. (2017). Effects of two modes of peer tutoring instructional strategies on senior secondary school students ‘acquisition of skills in chemistry practical. NOUN Journal of Education, 4, 186-195.
17. Bankole, I. S. (2018). Deploying card games as tools in learning chemistry concepts in Nigerian Classrooms. Journal of Chemical society of Nigeria, 43(3).
18. Dansu, T. V., (2022). Impact of Indigenous Knowledge System and Practices (IKSP) on Secondary School Students’ Comprehension and Entrepreneurship Skill in Chemistry Concepts. [Master’s Dissertation], Africa

Centre of Excellence for Innovative and Transformative STEM Education, Lagos State University, Ojo, Nigeria.
19. Egerue, I. C. (2019). Impact of sociocultural factors on scientific explanations in genetics and ecology offered by senior secondary students in Lagos State. Doctoral thesis in progress, Lagos State University, Nigeria.
20. Hwang, J., & Ham, Y. (2021). Relationship between Mathematical Literacy and Opportunity to Learn with Different Types of Mathematical Tasks. Journal on Mathematics Education, 12(2), 199-222.
21. Ikpah, C. E. (2022). Exploring the Efficacy of Culturo-Techno-Contextual Approach on the Achievement and Attitude of Senior School Students in Networking – A Difficult Concept in Computer Studies [Unpublished master's thesis]. Lagos State University.
22. Martínez, A. J. G. 2020. "ACE 812-912: Science Education: A Sociocultural View." LASU-ACEITSE, MP4. From Africa Center of Excellence for Innovative and Transformative STEM Education. YouTube, 53: 36. https://www.youtube.com/watch?v=VIVT6xclRuY
23. Nzewi, U. M. (2020). "ACE 812-912: Recent Developments in Gender Issues in STEM Education." LASUACEITSE, MP4. From Africa Center of Excellence for Innovative and Transformative STEM Education. Youtube.com/watch?v=mcbpmMgjis4&t=765s
24. Okebukola, P. A. (2021). Fostering Science Teaching and Learning in a Multicultural Environment Through the Culturo-Techno-Contextual Approach. In International Handbook of Research on Multicultural Science Education (pp. 1-39). Cham: Springer International Publishing.
25. Okebukola, P. A. O., Ige, K., Oyeyemi, A. Olusesi, O., Owolabi, O., Okebukola, F. & Osun, G. (2016). Exploring the Impact of Culturo-Techno-Contextual Approach (CTCA) in Tackling Under-Achievement in Difficult Concepts in Biology. Proceedings of the 2016 Conference of the National Association of Research in Science Teaching (NARST), Baltimore, USA.
26. Oladejo, A. I. &Ebisin, A. F. (2021). Virtual Laboratory: An Alternative Laboratory for Science Teaching and Learning. Federal Polytechnic Ilaro Journal of Pure and Applied Science, 3(1), 82- 90.
27. Oladejo, A. I., Okebukola, P. A., Olateju, T. T., Akinola, V. O., Ebisin, A., &Dansu, T. V. (2022). In Search of Culturally Responsive Tools for Meaningful Learning of Chemistry in Africa: We Stumbled on the Culturo-Techno-Contextual Approach. Journal of Chemical Education, Journal of Chemical Education, 99(8), 2919-2931. https://doi.org/10.1021/acs.jchemed.2c00126.
28. Oludipe, D. I. (2012). Gender difference in Nigerian junior secondary students' academic achievement in basic science. Journal of educational and social research, 2(1), 93-93.
29. Onowugbeda, F. U., Okebukola, P. A., Agbanimu, D. O., Ajayi, O. A., Oladejo, A. I., Awaah, F., ... & Ige, A. M. (2022b). Can the culturo-techno-contextual approach (CTCA) promote students' meaningful learning of concepts in variation and evolution? Research in Science & Technological Education, 1-17. https://doi.org/10.1080/02635143.2022.2084060
30. Rüller, S., Aal, K., Holdermann, S., Tolmie, P., Hartmann, A., Rohde, M., ... & Wulf, V. (2022). 'Technology is Everywhere, we have the Opportunity to Learn it in the Valley': The Appropriation of a Socio-Technical Enabling Infrastructure in the Moroccan High Atlas. Computer Supported Cooperative Work (CSCW), 31(2), 197-236.
31. Saanu, T. (2015). Exploration of the effect of the culturo-techno-contextual approach on the achievement and attitude of students in logic gate. Unpublished Master's Project Report, Lagos State University, Lagos, Nigeria.
32. Tunnicliffe, S. D. (2022). Play and STEM Foundations in the Earliest Years. In Play and STEM Education in the Early Years (pp. 39-63). Springer, Cham.
33. Urick, A., Wilson, A. S., Ford, T. G., Frick, W. C., & Wronowski, M. L. (2018). Testing a framework of math progress indicators for ESSA: How opportunity to learn and instructional leadership matter. Educational Administration Quarterly, 54(3), 396-438.
34. Uzezi, J. G., & Deya, G. D. (2020). Effect of Computer Simulation on Secondary School Students' Academic Achievement in Acid-Base Reactions. ATBU Journal of Science, Technology and Education, 8(1), 286-295.
35. Uzezi, J. G., Ezekiel, D., & Auwal, A. M. (2017). Assessment of Conceptual Difficulties in Chemistry Syllabus of the Nigerian Science Curriculum as Perceived by High School College Students. American Journal of Educational Research, 5(7), 710-716.
36. Vygotsky, L. (1978). Mind in society: The development of higher psychological processes.
37. Vygotsky, l. S. (1962). Thought and Language. Cambridge, MA: MIT Press.