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EXPLORING THE EFFICACY OF THE CULTURO-TECHNO-CONTEXTUAL APPROACH IN ENHANCING STUDENTS' KNOWLEDGE RETENTION IN FLOWCHARTS AND ALGORITHMS

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ABSTRACT

The goal of this study was to examine the effectiveness of CTCA on students' retention. Participants were 185 junior secondary school III students from two purposively elected schools in Lagos State Education District V. The flowchart and algorithm achievement test, with a reliability value of 0.74, was used to collect the quantitative data. All the 185 students used for the experimental and control groups were given a pre-test to determine the entry level of the students. After the pre-test exercise, the treatment was implemented for four weeks. The experimental group of students received four weeks of instruction by applying CTCA. The control group of students (n = 82) learned in the same way as the experimental class, but without any CTCA components. At the end of the treatment phase, all the students were given a posttest on the same evaluative achievement instruments and a retention test four weeks after the posttest exercise. Results on the ANCOVA output showed a statistically significant difference in the knowledge retention measure [F (1,185) = 145.21; p .05]. This implied that CTCA brought about better retention of concepts in the flowchart and algorithm than the lecture method.

Keywords: Meaningful learning; Cultural knowledge; Retention

Introduction

Education remains a vital pillar of national development, and its overall impact largely depends on how effectively learners are engaged and guided through different stages of the academic system. In recent years, scholars have increasingly focused on the challenge of student retention in secondary schools, particularly the factors that influence students' ability to remain in school and progress successfully. Retention encompasses not only continued enrolment but also the capacity of learners to advance academically from one level to another. The failure of students to sustain progress within the educational system raises critical concerns about both individual learning outcomes and the performance of the educational sector as a whole. Retention, encompassing the ability of students to persist and transition seamlessly through all levels, has far-reaching implications on individual educational attainment and the broader educational system.

The secondary school phase is a defining stage in a learner's academic trajectory, serving as the transition between foundational and advanced learning. When students struggle to retain key concepts at this level, their academic growth, self-development, and prospects are adversely affected. Addressing this issue requires examining the multidimensional causes of poor retention, which may include socio-economic background, home environment, school conditions, and most importantly, the nature of instructional strategies employed by teachers. In Nigeria, it has been determined that the use of ineffective teaching techniques by senior secondary school instructors is a significant factor in the subpar performance of students and also the ability to recall what they are taught (Ahmed & Abimbola, 2011; Kareem, 2003; Umar, 2011). The traditional pedagogical approach involves a classroom setting where the teacher delivers lectures and provides direct instructions.

This pedagogical approach prioritizes instructor guidance throughout the learning process. Students are required to attentively listen to lectures and acquire knowledge from them. The teacher frequently engages in monologues rather than fostering student interaction, inquiry, or comprehensive comprehension of the subject. The majority of classes typically use rote learning, wherein students rely on memorization without attaining a comprehensive comprehension of the subject matter. Successfully completing the program requires passing many types of assessments, including descriptions, matching, and other sorts of indicators (Adegoke, 2011; Umar, 2011). The continuous utilization of this approach renders students as passive rather than active learners. The aforementioned studies (Ahmed, 2008; Ahmed & Abimbola, 2011; Kareem, 2003; Umar, 2011) indicate that it fails to encourage deep understanding and lasting memory of certain abstract concepts. In the current day, it is imperative to promote an inspiring and engaging methodology to enhance students' comprehension, assimilation, and retention of concepts, as well as to foster their future engagement in

STEM-related concepts. A possible technique, as suggested by Onowugbeda et. al (2022), is to use multimedia presentations that include visual and verbal elements together with photos, animations, texts, narration, and students' cultural practices as an example.

Retentiveness is an index that pertains to the duration and utilization of newly acquired and previously acquired knowledge in memory (Yilmaz and Cakmak 2012). It involves utilizing the accumulated information and deliberate application of that knowledge throughout time. Acquiring knowledge. Teaching methods and approaches for information retention, especially in the context of science disciplines, particularly when it comes to teaching concepts in information technology, are often not well utilized despite their critical importance (Gbeleyi et al., 2022; Onowugbeda, 2020; and Peter et al., 2022). Throughout time, it has been observed that students often face difficulties in retaining knowledge (Chow, Kelly, Woodford, & Maes, 2011). Research indicates a correlation between the manner in which a topic is taught, where the emphasis may be on cultivating students' meaningful comprehension and enthusiasm for learning, rather than overwhelming them with dense lectures filled with facts and abstracts. According to Odoh (2024), he opined that retention is the ability of students to remember, recall, and apply what they have been taught over time, which measures how well knowledge, skills, and concepts stay in a learner's memory and can be used in future learning situations, tests, or real-life applications. High student retention of learning means that teaching has been effective and learning has been long-lasting.

Seeing the importance of retention in students' academic performance, several studies have shown that there is an increase in failure recorded by students in external examinations can be attributed to their inability to remember what they have been taught (Onowugbeda et. al, 2022). Retention expresses how long recently acquired and acquired knowledge is retained in memory and how it is used and recalled (Yilmaz and Cakmak 2012), which can only occur when there is meaningful learning. Irrespective of how important this is, teaching strategies used in most African classrooms do not promote retention (Onowugbeda et al., 2022).

Instructors must focus on students' long-term retention failure following the first education. The consensus among most individuals is that a substantial portion of the knowledge acquired in educational institutions is subsequently forgotten, posing a serious challenge for the field of education. In recent years, there has been increased attention on studying the impact of the culturo-techno-contextual approach (CTCA) on students' learning. During the implementation of CTCA, students engage in collaborative group work to achieve a shared objective, while also delivering their results, typically with the guidance of a mentor. The CTCA prioritizes the integration of existing knowledge with new information, taking into

account the learners' surroundings. In the realm of scientific education, these studies have the capacity to greatly facilitate meaningful and enduring learning (Awaah et al, 2021; Oladejo et al, 2022; Okebukola et al, 2021; Onowugbeda et al, 2022a; and Onowugbeda et al, 2022b). Previous studies have confirmed CTCA's potential in fostering deep understanding and long-term learning in STEM education (Agbanimu et al., 2021; Onowugbeda, 2021; Peter et al., 2022). Consequently, this study investigates the extent to which CTCA can enhance students' retention of flowchart and algorithm concepts in computer studies, focusing on how culturally contextualized, technology-mediated learning improves recall and comprehension.

Culturo-Techno-Contextual Approach

The Culturo-Techno-Contextual Approach creates and employs new techniques for removing obstacles to the meaningful acquisition of scientific concepts. When compared to the traditional teaching technique, several teaching approaches created over the years have demonstrated a statistically significant difference in favour of the respective groups they were employed for. However, in science subjects, students ' performances have been erratic. Several methods of teaching science have been found to improve the learning of science concepts. These methods include cooperative learning, concept-mapping, discovery learning, demonstration, argumentation, mastery learning, and Vee diagramming. Most of the aforementioned methods have failed to promote meaningful learning of STEM-related subjects or courses to a level that can be regarded as significant in the face of contextual mitigating factors. The CTCA (Culturo-Techno-contextual Approach) was created in response to the need for a technique that will promote meaningful learning and improve students ' performance on academic and public examinations. Around the world, cultural and environmental circumstances have a significant impact on how well science is taught and how meaningfully it is learned.

This approach is a fusion of three frameworks-

- cultural context in which all learners are immersed; -
- technology mediation to which teachers and learners are increasingly dependent; -
- locational context, which is a unique identity of every school that plays a role in the examples and local case studies for science teaching.

Five main steps are involved in implementing CTCA in a classroom setting: students engage in activities that require them to

- utilize their native (cultural) knowledge that is pertinent to the topic
- seek pre-lesson understanding of the subject to be covered in the classroom or laboratory using technology.
- collaborate in groups to exchange knowledge gained from their sociocultural interactions and

presumably obtained web-based resources.

- when the class is in session, draw on their prior knowledge of the subject, and
- integrate examples from lessons into local contexts (Okebukola, 2015).

Theoretical framework

CTCA is premised on Vygotsky's theory of social constructivism and Ausubel's theory of advance organizer. The philosophical framework is Michael Williams' contextualism, Kwame Nkrumah's Ethnophilosophy, Martin Heidegger's Technophilosophy, and Okebukola's Eco-Cultural Theory. In Vygotsky's theory, CTCA exposes students to social interactions on two fronts-cultural and indigenous knowledge, and group interactions with fellow students. These two fronts install scaffolds that promote learning within the zone of proximal development (ZPD) espoused by Vygotsky (1962; 1978). The learners can interact with a more knowledgeable person who has experience and has gone through worthy cultural practices associated with the specific concepts to be taught. Regarding Ausubel's theory of advanced organizer, Ausubel (1963) proposes the concept of an advanced organizer to assist students in connecting their conceptualisations or imaginations with new material or concepts. These broader concepts or ideas are advanced organizers (Ausubel, 1978). This is related to CTCA, whose procedure requires learners to link ideas or discover relationships between concepts using prior knowledge of the subject matter in order to foster deep or meaningful learning. CTCA's context element is based on Michael Williams' Contextualism philosophical framework. Contextualism asserts that our actions, utterances, expressions, and learning can only be understood in their context. When using CTCA to teach students, the content should apply to their immediate surroundings so that they can quickly capture the explanation. Additionally, the study of indigenous philosophical systems is known as ethnophilosophy. It is based on the idea that a specific culture, such as that of the Yoruba or Igbo in Nigeria, can have a philosophy that is not applicable or accessible to all people and cultures around the world, while also sharing some similarities with other cultures of the world. Kwame Nkrumah first used this philosophy, which he saw as a combination of ethnography and philosophy, primarily concerned with Africans and their way of life.

The philosophy of CTCA's techno component can be traced back to Martin Heidegger. In the view of Heidegger, technology must be understood as a "way of revealing" (Heidegger 1977, 12). Even though he philosophized long before the rapid advances in technology that we are now witnessing, what we call "reality" is not defined the same way in all times and cultures. "Reality" is not something absolute that humans can ever fully comprehend. It is relative in the world's most literal sense. Heidegger focuses on using technology that sees it as an end to stimulate learners' interest in the classroom. Technology embodies an explicit way of revealing the world, a

revealing in which humans take power over reality for Heidegger.

Objectives

The objective of this study is to improve the retention of students in Nigerian secondary schools by exploring the potency of the culture-techno-contextual approach on students' ability to retain what they have learnt in information technology.

Research question

Will CTCA improve the retention of students taught the flowchart and algorithm?

Hypothesis

There is no statistically significant difference in the retention of students taught a flowchart and algorithm using a culturo-techno-contextual-approach and those taught using the conventional teaching method.

Methodology

This study employed a quasi-experimental design, specifically a pre-test, post-test non-equivalent group design, due to the inability of the researchers to randomly assign participants to the control and experimental groups during data collection. In addition, a quantitative technique was employed to utilize numerical data for conducting statistical analysis in order to determine the considerable disparity in retention among students taught a flowchart and algorithm utilizing CTCA, compared to those taught using the traditional teaching method. The data was gathered using the Flowchart and Algorithm achievement test, and also an interview guide to conduct a comprehensive investigation of the problem and enhance the level of focus. Flowchart and Algorithm were used because it's emerged as the most difficult concepts in a study conducted by Agbanimu et.al (2020), and the chief examiner's report in 2018 indicated that most students avoided questions related to programming language, in which understanding flowchart and algorithm is a benchmark.

The sample comprised 185 Junior Secondary School III students drawn from two purposively selected public schools within Lagos State Education District V. The students were enrolled in Information Technology (IT) courses but had not yet been introduced to flowchart and algorithm concepts in their curriculum. Of these, 103 students (48 males and 55 females) were assigned to the experimental group, while 82 students (38 males and 44 females) formed the control group. Participants' ages ranged from 10 to 15 years, with a mean age of approximately 12 years.
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Data were collected using the Flowchart and Algorithm Achievement Test (FAAT), designed to measure students' understanding and retention of key programming concepts. The initial test contained 30 multiple-choice items adapted from past West African Examinations Council (WAEC) papers to ensure validity and standardization. A panel of five experienced IT educators and test development experts reviewed the items for content relevance, cognitive level distribution, and coverage of the syllabus.

Based on their evaluation, 20 items were selected for the final version of the instrument.

The test was structured according to Bloom's taxonomy, ensuring that approximately 30% of the items assessed comprehension, 20% application, 10% analysis, 10% synthesis, and 10% evaluation. Reliability was established using the split-half method, and the Spearman-Brown coefficient yielded a value of 0.74, confirming acceptable internal consistency for the test. Both groups were administered a pre-test to assess baseline knowledge prior to instruction. The experimental group received four weeks of lessons conducted using CTCA, while the control group was taught using the traditional lecture-based method. The CTCA implementation followed a five-step procedure.

1. In the first activity for the CTCA in the classroom, the teacher would inform the students on the topic on cultural practices and beliefs associated with the concept, asking them to watch YouTube videos and search the web for ideas as well using their mobile phones or internet-enabled devices which sought out to be the technology flavour of the approach, they also ask their parents or people in their community on indigenous knowledge related to flowchart and algorithm. The learners were made to understand that they would be divided into groups to discuss the findings from their prelesson activity (assignment), and a group leader would also be assigned to coordinate. And this promotes leadership skills and teamwork among these learners, which serves as a core skill for the 21st century. This is the first step, and it serves as the starting point for using an advanced organizer and applying Vygotsky's concept of the zone of proximal development.

2. At the inception of the lesson, the teacher groups the students into mixed ability, mixed sex groups depending on the population of the class, and also, as instructed ahead of time to enable the learner to interact within themselves for 10 minutes on individual knowledge concerning the (a) the indigenous knowledge and cultural practices related to flowchart and algorithm (b) summaries of idea obtained from web resources, all cultural and web-based reflections, there were 10 groups in total, comprising 11 students for three groups and 10 students each for seven groups in the class making a total of 103 students. All their discoveries were noted as the group leaders made their presentations to the class for about 5 minutes each. The class time allocated to teaching computer studies for the experimental phase was 80 minutes. The teacher wraps up by sharing their indigenous knowledge and cultural practices associated with the flowchart and

algorithm. This reflects the application of Vygotsky's concept of ZPD, scaffolding, and peer tutoring, which is the second step in implementing CTCA.

3. The lesson progressed with the teacher sharing her indigenous knowledge and cultural practices associated with flowcharts and algorithms, and giving examples that students can easily relate to in their environment. These examples denote the context flavour of the approach. The teacher delivers the content of the concept through the interaction between the students and teachers with some content-specific humour. For example, the process involved in tapping palm wine was used to explain the step-by-step process involved in solving a problem or developing an algorithm. This is the third step of implementing CTCA, and it reflects the use of relevant examples from the environment to aid meaningful learning. Throughout the teaching and learning process, the class is reminded of the relevance of the indigenous knowledge and the cultural practices presented by the groups, and also the misconceptions associated with cultural beliefs are cleared by the teacher; this reflects Nkrumah's ethnophilosophy to reinforce learning, which is the fourth step in implementing CTCA.

4. As the lesson pressed on, the students were stirred up by the significance of the indigenous knowledge and cultural practices presented by the groups for a meaningful understanding of the concepts. The teacher made sure to clear any misconceptions associated with the cultural practices shared by the students.

5. At the conclusion of the class, the teacher informs the students to expect a maximum of 320-character summary of the lesson on their phones, which will come via SMS or WhatsApp, and also informs the students that after this first lesson, the student group leaders are to send such messages. Before he leaves the students, the teacher informs them of the next sub-topic and then to (a) reflect on cultural knowledge or practices and beliefs associated with the sub-topic. The teacher tells the students to discuss the assignments with their parents/guidance, or anyone who can help at home. He informs the students that such reflections will be shared with others at the beginning of the practical class, and (b) search the web for resources relating to the next sub-topic using their mobile phones or other internet-enabled devices. This is the fifth and last step of implementing CTCA in the classroom, another of the technology flavours of the approach, and it reflects the application of

Heidegger's technophilosophy and advanced organiser.

After the instructional phase, all students took a post-test, and a retention test followed four weeks later to assess long-term knowledge retention. The same achievement instrument (FAAT) was used
for both evaluations. Data were analyzed using IBM SPSS Version 23. The Analysis of Covariance (ANCOVA) technique was applied to compare retention outcomes between groups while controlling for pre-test differences. The pre-test scores served as the covariate, ensuring that variations in initial ability did not confound the results. Statistical significance was determined at
the 0.05 level.

Results Of Data Analysis

The findings derived from the descriptive analysis indicate that the average scores of students in both the experimental and control classes were similar before the implementation of the intervention. Specifically, the mean score for the experimental class was 5.40, while the mean score for the control class was 5.68. Following the implementation of the intervention, it is noteworthy that the experimental group students exhibited a higher mean achievement score of 13.94 on the post-test measure. This score is twice as high as the mean score of 7.67 observed among the control group students, as indicated in Table 1. For the retention test the which was conducted four weeks after treatment the scores indicated that the experimental group not only outperformed their counterparts in the posttest but also with the retention test with the mean score of [experimental 15.78; control 7.54] The data indicates that the students in the experimental group exhibited greater improvement in their scores when compared to their peers in the control group. Therefore, to determine the presence of a significant difference, the retention data were subjected to analysis of covariance, with the pre-test achievement scores serving as the covariate.

Table 1: Means and SD on the post-test Achievement Scores of Students in the Experimental and Control Groups

Group	N	Mean	SD
Experimental	103	13.94	5.50
Control	82	7.67	4.85
Total	185	13.61	5.19

Table 2: Means and SD on the retention-test Scores of Students in the Experimental and Control Groups

Group	N	Mean	SD
Experimental	103	15.78	4.64
Control	82	7.54	4.09
Total	185	6.32	4.20

The study addressed whether CTCA will be able to improve students' knowledge retention. Findings from descriptive statistics showed that students exposed culturo-techno-contextual approach had the highest mean score of knowledge retention when compared to their counterparts [CTCA - 15.78; traditional lecture method 6.32]. The ANCOVA results revealed a statistically significant difference in the knowledge retention measure of the students [F (1,185) = 145.21; $p < .05$].

Table 3: Analysis of Covariance on the Retention-test Scores of Students in the Experimental and Control Group with Pre-test Achievement Scores as the Covariate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Methods	1435.210	1	1435.210	145.21	.000
Error	599.24	185	5.656		

Discussion

This supports the conclusions of Onowugbeda (2022) that using cultural and contextual examples can improve students' performance and retention in biology, and Khishfe's (2015) study showed that detailed instruction improved the retention of acquired knowledge about the features of the nature of science. The studies conducted by Ozden & Gultekin (2008), Sarikaya et al. (2010), and Upadhyay & DeFranco (2008) provide more evidence that learners can recall science concepts. The CTCA framework, which includes culture, technology, and context, could explain the significant difference in knowledge retention. When students' learned concepts are linked to relevant examples in their surroundings, connected to their respective cultures, and actively involved during the lesson, they tend to retain that knowledge for a long time.

The notable disparity in information retention may be attributed to the framework of CTCA, encompassing the elements of culture, technology, and context. When the students were able to relate the taught concepts to their own cultures and connect these concepts to relevant instances in their environment, they were more likely to remember that knowledge for an extended period of time. Okebukola (2020) states that the cerebral cortex is the specific region of the brain that is engaged in the process of learning when CTCA is used in educational settings such as classrooms, laboratories, or fieldwork. Interestingly, this is the area of the skull that individuals often instinctively touch or scratch while attempting to find solutions to problems. Learning occurs when knowledge is stored in either long-term memory (LTM) or short-term memory (STM).

STM data is only retained for a very brief amount of time. If this material is not practiced or repeated, it will eventually fade from memory. In the CTCA, students obtained pertinent information from the internet and YouTube videos in addition to information on indigenous knowledge and

cultural practices from a more knowledgeable source. Since the pupils had never heard of this information previously, it was retained in short-term memory. When they are divided into mixed-sex groups according to their talents during class activities, they use the information stored in the STM to create their presentations. They are able to absorb knowledge into the long-term memory store and engage in meaningful learning when they accomplish this with ease (Ausubel, 2012; Novak, 2010). This explains why, following four weeks of treatment and a post-test, a student who had meaningfully understood a concept was able to recall and apply the material with ease on the retention test. Table 1 displays selected findings from the qualitative analysis.

Table 4: Excerpt from qualitative findings reported unedited

Student A	This approach to teaching math is fascinating. I was reminded of what we were taught by our presentations.
Student B	Because of the group assignment and our collaborative work, I was able to recall.
Student C	I was able to remember the lesson because of the cultural examples you provided and other examples you provided.
Student D	Although I feel we took a longer time but I enjoyed all the processes because it helped me remember how the algorithm was explained, and also identifying the flowchart symbols.

Additionally, the CTCA group enthusiastically engaged in the group presentation of the cultural traditions connected to the lessons they had learnt. Every child in the group was in favor of contributing ideas from their individual homes to the first phase of the CTCA implementation in the classroom. As a result, each individual in the group has gained knowledge, understood it, and is able to remember it when necessary. Additionally, the students tended to remember when they watched and heard the teacher's thorough explanation of the significance of the cultural traditions and online resources presented. Although a teacher can convey knowledge, learning genuinely occurs when a student builds their own knowledge base from their own experiences (Al-Huneidi and Schreurs 2013). This highlights the interdependence and close relationship between knowledge, skills, and independent study, which highlights the role of CTCA in helping students retain their knowledge.

Conclusion

This study reinforces the importance of employing instructional approaches that cultivate meaningful learning and enduring knowledge retention. The findings demonstrate that the Culturo-Techno-Contextual Approach (CTCA) significantly improved students' ability to retain and recall concepts related to flowchart and algorithm when compared with the conventional lecture method. By emphasizing cultural relevance, contextual understanding, and technological integration, CTCA provided learners with multiple pathways for internalizing abstract concepts and connecting them to real-life

experiences. For students to retain key knowledge effectively, teachers must employ strategies that combine active participation, contextual scaffolding, and continuous reflection. The CTCA model offers a structured avenue for achieving these objectives through its balance of cultural activation, collaborative learning, and technological reinforcement.

Recommendations

1. Adopt Diverse and Culturally Responsive Teaching Strategies: Teachers should integrate cultural examples, local experiences, and context-based illustrations into instruction to make abstract concepts more relatable and memorable.
2. Leverage Technology for Reinforcement: Educational institutions should encourage the use of digital tools such as short video clips, mobile reminders, and virtual discussions to strengthen knowledge recall and promote continuous engagement.
3. Promote Student-Centered Learning: Instructional design should emphasize collaboration, inquiry, and problem-solving to enable learners to construct their own understanding rather than rely solely on rote memorization.
4. Ongoing Evaluation and Feedback: Implementing CTCA should include systematic monitoring, student feedback, and periodic revisions to ensure its continuous effectiveness across different learning contexts.
5. Capacity Building for Educators: Teacher training programs should incorporate CTCA principles, focusing on integrating cultural awareness, contextual teaching, and technological proficiency in classroom practice.

By merging cultural sensitivity, technological mediation, and contextual relevance, the Culturo-Techno-Contextual Approach provides a sustainable framework for fostering meaningful and enduring learning experiences. As digital and blended learning environments continue to expand globally, CTCA offers a promising model for advancing effective pedagogy across African and other developing educational contexts.

REFERENCES

Adam, U. A., Lameed, S. N., Tonade, O., Onowugbeda, F. U., Ayodeji, B., Michael, I. A., & Muraina, I. O. (2023). A New Piece of the Puzzle: Deploying Technologically-Enhanced Jigsaw Method to Solve the Puzzle of Meaningful Learning in Biology. *ASEANA Science and Education Journal*, 3(1), 8-17.

Agbanimu, D. O., Okebukola, P. A., Onowugbeda, F. U., Peter, E. O., Oladejo, A. I., Awaah, F., ... & Allename, F. A. (2022). Flowchart and Algorithm as Difficult Concepts

in Computer Studies: Can CTCA Come to the Rescue? [Conference paper]. NARST 95th Annual International Conference: Unity and Inclusion for Global Scientific Literacy: Invite as a Community. Unite as a Community, Vancouver. British Columbia.

Ausubel, D. (1963). The psychology of meaningful verbal learning. New York: Grune & Stratton.

Ausubel, D. (1978). In defense of advance organizers: A reply to the critics. Review of Educational Research, 48, 251-257.

Ausubel, D. P. (2012). Reception learning and the rote-meaningful dimension. In Readings in Educational Psychology (pp. 204-231). Routledge.

Awaah, F., Okebukola, P., Shabani, J., Raheem, K., Ahove, M., Onowugbeda, F., & Agbanimu, D. (2021). Will cultural teaching methods influence student understanding of politics and bureaucracy in the public administration curriculum of African countries during the COVID-19 pandemic? Teaching Public Administration, 01447394211058167.

Chow, A. F., Kelly, C., Woodford, K. C., & Maes, J. (2011). Deal or no deal: Using games to improve student learning, retention, and decision-making. *International Journal of Mathematical Education in Science and Technology*, 42(2), 259–264.

Odoh, C. E. (2024). Effect of Interactive Whiteboards (Iwbs) on Academic Achievement and Retention in Computer Studies among Junior Secondary Schools in Abuja Municipal Area Council, FCT. *Journal of Continuing and Development Education*, *4*(1), 30-38.

Okebukola, P. A. O (2020). Breaking barriers to learning: The culture-techno-contextual approach (CTCA). Slough, UK and Delhi, India: Sterling Publishers.

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*.

Onowugbeda F. U. (2020). Variation and Genetics as Difficult Topics for Secondary School Students in Biology: Exploring the Impact of Indigenous (Cultural) Knowledge for Better Understanding. In Peter Okebukola (Ed.). Breaking barriers to learning: The culture-techno-contextual approach (CTCA). Slough, UK and Delhi, India: Sterling Publishers

Onowugbeda, F. U., Okebukola, P. A., Agbanimu, D. O., Ajayi, O. A., Oladejo, A. I., Awaah, F., ... & Ige, A. M. (2022a). Can the culturo-techno-contextual approach (CTCA) promote students' meaningful learning of concepts in variation and

evolution? *Research in Science & Technological Education*, 1-17.

Ozden, M., & Gultekin, M. (2008). The effects of brain-based learning on academic achievement and retention of knowledge in a science course. *Electronic Journal of Science Education*, 12(1), 1–17.

Peter. E. O., Okebukola, P. A., Peter, D. G., Agbanimu, D. O., Awaah, F., Onowugbeda, F. U., & Imole, S. (2022). Exploring the Potency of Culturo-Techno-Contextual Approach on Achievement of Secondary School Students in Computer Networking [Conference paper]. NARST 95th Annual International Conference: Unity and Inclusion for Global Scientific Literacy: Invite as a Community. Unite as a Community, Vancouver. British Columbia

Idi, J., Asogwa, S.C., & Odoh, C.E. (2021). Influence of Use of Social Networking Sites on Academic Achievement of Senior Secondary School Students in Enugu State. T*rends in Educational Studies Journal* (TRESJ) 13(1). University of Port Harcourt

Rola Khishfe (2015) A Look into Students' Retention of Acquired Nature of Science Understandings, *International Journal of Science Education*, 37:10, 1639-1667, DOI: 10.1080/09500693.2015.1049241

Sarikaya, M., Guven, E., Goksu, V., & Aka, E. (2010). The impact of the constructivist approach on students' academic achievement and retention of knowledge. Elementary Education Online, 9(1), 413–423. Retrieved from http://ilkogretim-online.org.tr

Upadhyay, B., & DeFranco, C. (2008). Elementary students' retention of environmental science knowledge: Connected science instruction versus direct instruction. *Journal of Elementary Science Education*, 20(2), 23–37.

Vygotsky, L. S. (1962). Thought and Language. Cambridge, MA: MIT Press.

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Yılmaz, R., and E. Kılıç Çakmak. 2012. "Educational İnterface Agents as Social Models to İnfluence Learning, Achievement, Attitude and Retention of Learning." Computers & Education 59: 828–838.