

Reducing Underachievement and Promoting Critical Thinking Skills in Computer Studies Through a Culturally Sensitive Instructional Method

La reducció del baix rendiment acadèmic i el foment de les capacitats de pensament crític en informàtica mitjançant un mètode d'ensenyament culturalment sensible

La reducción del bajo rendimiento académico y el fomento de las capacidades de pensamiento crítico en informática mediante un método de enseñanza culturalmente sensible

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ABSTRACT: This study aims to determine the effectiveness of the Culturo-Techno-Contextual Approach (CTCA) on students' achievement and critical thinking skills in Computer Studies. The study was conducted in two phases. Phase one was a survey of difficult concepts in computer science/studies. While phase two explored the potency of the Culturo-Techno-Contextual Approach (CTCA) in breaking the barriers to meaningful learning of refractive indices. Results obtained from the survey in the first phase revealed 19 topics as a difficult topic among African secondary school students in computer studies. The second phase was guided by two research questions with two public junior secondary (JS) in Lagos State (Nigeria). About 38% of the respondents were males while about 62% were females. A critical thinking skills task (CTST), and an interview guide were used to collect data for the study. The data gathered was subjected to multivariate analysis of covariance (MANCOVA), and the results revealed a statistically significant difference in the methods used, multivariate F (Pillai's Trace) was significant [$F=17.67$; $p<.05$], univariate ANOVA on achievement [$F(2, 208) = 20.67$; $p<0.05$]; and critical thinking skills [$F(2, 208) = 15.14$; $p<0.05$]. Within the scope of the study, it was tentatively recommended that CTCA should be adopted by computer studies teachers in the teaching of computer science/studies in secondary schools.

KEYWORDS: CTCA; Computer Studies; CTS; Students Achievement; Secondary School; Nigeria

RESUMEN: Este estudio analiza la eficacia del enfoque Culturo-Tecno-Contextual (CTCA) en el rendimiento y las habilidades de pensamiento crítico de los estudiantes de Informática. El estudio se llevó a cabo en dos fases. La primera fase consistió en un estudio de conceptos difíciles en Informática, mientras que la segunda fase exploró la capacidad de acción del enfoque Culturo-Tecno-Contextual (CTCA) para romper las barreras del aprendizaje significativo de los índices de refracción. Los resultados obtenidos de la encuesta de la primera fase revelaron la existencia de 19 temas especialmente difíciles en informática en los estudiantes africanos analizados. La segunda fase se guió por dos preguntas de investigación realizadas en una muestra de estudiantes de dos centros públicos de enseñanza secundaria de primer ciclo (JS) del Estado de Lagos (Nigeria). Aproximadamente el 38%

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de los encuestados eran varones, y el 62%, mujeres. Para recopilar los datos del estudio se utilizó una actividad de desarrollo del pensamiento crítico y entrevista guiada. Los datos recogidos se sometieron a un análisis multivariante de covariantes (MANCOVA), y los resultados revelaron una diferencia estadísticamente significativa en los métodos utilizados; la F multivariante (traza de Pillai) fue significativa [$F=17,67$; $p<0,05$], ANOVA univariante sobre el rendimiento [$F(2, 208) = 20,67$; $p<0,05$]; y habilidades de pensamiento crítico [$F(2, 208) = 15,14$; $p<0,05$]. Como consecuencia de este estudio, se recomienda que los profesores de informática adopten el CTCA en la enseñanza de la informática/estudios informáticos en secundaria.

PALABRAS CLAVE: CTCA; estudios de informática; CTS; resultados académicos; escuela secundaria; Nigeria

RESUM: Aquest estudi analitza l'eficàcia de l'enfocament cultural-tecnològic-contextual (CTC) en el rendiment i les habilitats de pensament crític dels estudiants d'informàtica. L'estudi es va dur a terme en dues fases. La primera fase va consistir en un estudi de conceptes difícils en informàtica, mentre que la segona fase va explorar la capacitat d'acció de l'enfocament cultural-tecnològic-contextual () per a trencar les barreres de l'aprenentatge significatiu dels índexs de refracció. Els resultats obtinguts de l'enquesta de la primera fase van revelar que hi havia 19 temes especialment difícils en informàtica per als estudiants africans analitzats. La segona fase es va guiar per dues preguntes d'investigació realitzades a una mostra d'estudiants de dos centres públics d'ensenyament secundari de primer cicle () de l'estat de Lagos (Nigèria). Aproximadament, el 38% dels enquestats eren homes i el 62%, dones. Per a recopilar les dades de l'estudi es va utilitzar una activitat de desenvolupament del pensament crític i entrevista guiada. Les dades arrellegades es van sotmetre a una anàlisi de () i els resultats van revelar una diferència significativa en els mètodes utilitzats; la (traza de) va ser significativa [$F=17,67$; $<0,05$], sobre el rendiment [($2,208) = 20,67$; $<0,05$]; i habilitats de pensament crític [($2,208) = 15,14$; $<0,05$]. La conseqüència d'aquest estudi és que els professors d'informàtica adopten l'ensenyament de la informàtica/estudis informàtics en secundària.

PARAULES CLAU: CTCA; estudis d'informàtica; CTS; resultats acadèmics; escola secundària; Nigèria

Practitioner Notes

What is already known about the topic

- The African continent, according to [Oladejo et al. \(2022a\)](#), is currently so backward in the acquisition and application of scientific knowledge relative to other regions of the world. The study sought to address the constantly recurring issue of students' poor performance and underachievement in science subjects (particularly in biology due to its wide range of concepts), the causes and its effect relating to the quality of students produced over the years, and its impact on the progressive growth and development of the nation as a whole. All these have contributed to several years of extensive research and development of different instructional strategies to help students learn and gain better understanding of difficult scientific concepts. While a number of these methods have been quite successful, [Okebukola \(2020\)](#) noted that they have singly or in combination failed to sustainably promote meaningful learning of science to a level that can be regarded as significant in the face of contextual mitigating factors.

What this paper adds

- The results revealed a statistically significant difference in the mean achievement scores of students taught using CTCA and those taught conventionally.
- The data gathered was subjected to multivariate analysis of covariate (MANCOVA), and the results revealed a statistically significant difference in the methods used, multivariate F (Pillai's Trace) was significant [$F=17.67$; $p<.05$], univariate ANOVA on achievement [$F(2, 208) = 20.67$; $p<0.05$]; and critical thinking skills [$F(2, 208) = 15.14$; $p<0.05$].

Implications of this research and / or paper

- The findings from this study provide empirical evidence that CTCA is a more effective instructional strategy for science instruction compared to the conventional method as evident in the higher mean achievement of students in the CTCA group.

- The study has also provided a practicable foundation for the improvement in the quality of science teaching and learning, hence, fostering effective teaching on the part of the teacher and meaningful learning on the part of the students.
- The advent of CTCA has also ensured that science teaching and learning is not just restricted to the four walls of a classroom.

1. INTRODUCTION

The search for more potent and satisfying methods of encouraging students' academic performance in computer studies has become inevitable. Such methods, techniques, strategies, or activities such as lecture methods, demonstrations, projects, discovery, discussions, field trips, use of concept maps, demonstrations, analogies, and laboratories with constructivist flavors have populated this literature. Yet, despite the deployment of some of these methods in computer science/studies classrooms, the same literature in the second decade of the 21st century is replete with reports of the lackluster performance of students in this subject in many countries' secondary or post-primary schools (Hoeg & Bencze, 2017).

As indigenous people from all around the world prompt us that our mindsets, spirituality, language, color, storytelling, dress code, and connectedness to the land are critical parts of our essential humanity and are necessary for our truly "knowing" the world, one another, and ourselves (Ife, 2001).

As African educators are gathering at regional and international conferences to promote the visibility of teaching computer science/studies as change agents in the fight against poverty and underdevelopment, the importance of culture and the context of practice remain critically relevant in education. Globalization and modernization continue to present challenges for teachers in Africa, and innovative methods in teaching theory, education, practice, ethics, and research are needed (Olaore & Drolet, 2017).

The confidence placed in the use of technology and other computing resources is an important support for the deep transformation toward processes of very high-quality teaching and learning based on active learning (Latorre-Coscolluela et al., 2021). Critical Thinking Skill (CTS) is enshrined in the education curriculum in Africa. It posits the application of scientific principles to assist students with reasoning abilities to establish connections to address real-world challenges. There is a need to constantly explore how computer studies education, sometimes called Data Processing or ICT Education, realizes it in Africa. In most cases, such investigations are carried out in classrooms having experienced teachers with a belief that the realisation of critical thinking skills may be manifest. What comes out of such searches is that teachers in the classroom have a narrow understanding of critical thinking and this is the way to go in meeting the SDG's goals with the African Agenda 2063 (Kola, 2015).

With these in mind, Educational Learning Institutions' (ELIs) main goal is to create lifelong learners for the social good. Schools serve as the foundation for a nation's development and growth in the modern, technologically and economically globalized world. According to Fejes, Nylund, and Wallin (2019), this is done by offering subjects that emphasize advanced technological knowledge and computer studies or Computer Science (CS).

Meaningful learning of computer science or other concepts places the footing that an individual has been able to personalised a new impetus, and it is echoed in the proficiency of applying the new knowledge gained to other situations. On the contrary, the outcome of traditional learning results is when a piece of new knowledge is frantically incorporated into the mental structure. Such individuals will be able to reminisce on the new information but unable to bring it into effect in solving new problems. While the emphasised goal of a computer science teacher is to ensure that all students can

learn computer science concepts meaningfully, many students, unfortunately, attain rote or recall-level learning (Onowugbeda et al., 2022).

The future is now. We need to get up to speed and time. It is imperative that we as educators look for ways to secure computer science education for our students. We need to rise to the occasion and offer our next generation a chance to succeed in the 21st century's next industrial revolution (Gbeleyi et al., 2022). Technology and manufacturing all point to the need to increase computer studies and CTS needed. This situation updates the countries' education systems and sometimes leads to drastic changes even in educational policies to adapt to the age. Throughout history, several pedagogical tools have been developed to help teachers navigate their way through the path of delivering quality education that can promote meaningful learning. In science education, these tools are growing in number and quality as newer tools build on the strengths of the older and indeed, make adjustments for the weaknesses of their predecessors. As it is, the quest for newer tools is unending in the face of the dynamism of society, knowledge, technology, and learner characteristics (Okebukola, 2020). It is within this search mode for improved pedagogical tools that the Culturo-Techno-Contextual Approach (CTCA) emerges a refreshing addition developed by Okebukola in 2015 and Gbeleyi 1.0 also came up by the Gbeleyi Olasunkanmi in 2019 which can be found in the Google Play store (Gbeleyi, n.d.).

Computer studies and CTS, from the foregoing is no doubt a unique and an important subject whose knowledge of is truly dear to the century as a whole now. It therefore, requires to be taught by competent teachers who can guide students towards achieving the desired educational goal. Despite that, there is a serious decline in students' achievement in computer studies at the secondary since its inclusion in the external examination from 2014 to date (Duze, 2012). Available chief examiners' reports of Basic Education Certificate Examinations (BECE) (*Basic Education Certificate Education (BECE)*, n.d.) from May/June 2016 to 2019 revealed the persistent average performance of students in the subject (Chukwudum, Okechukwu, Nnachi, & Aja, 2022). The poor teaching method could result from the continuous use of the lecture method of teaching in the classroom (Gbeleyi & Potokri, 2023).

The study intends to explore the potency of CTCA and Gbeleyi 1.0 (Gbeleyi, n.d.) on students' achievement, and critical thinking skills in computer studies at the Junior Secondary School in Lagos State (Nigeria). Two research questions were of interest. These are:

1. Is there a statistically significant difference in the achievement and critical thinking skills of students in computer studies taught using CTCA and Gbeleyi 1.0, and those taught with the lecture method? and
2. What are the perceptions of students on the CTCA?

2. THEORETICAL FRAMEWORKS FOR GBELEYI 1.0 AND CTCA

The three theoretical frameworks that build the foundation for utilizing mobile technology with students' language and context for this study are: Bloom's (1968) Mastery Learning Theory, McMillan's and Chavis (1986) Sense of Community Theory and Rovai's (2009) Online Sense of Community Theory (in McMillan and Chavis, 1986). Each provides a segment of understanding for students' language and mobile technology. Explaining each theory and how it connects to mobile technology and students' language provides a greater understanding of the benefits of mobile technology for students.

The Culturo-Techno-Contextual Approach (CTCA) is a method of teaching and learning science developed by Peter A. Okebukola in 2015 to break the barriers to

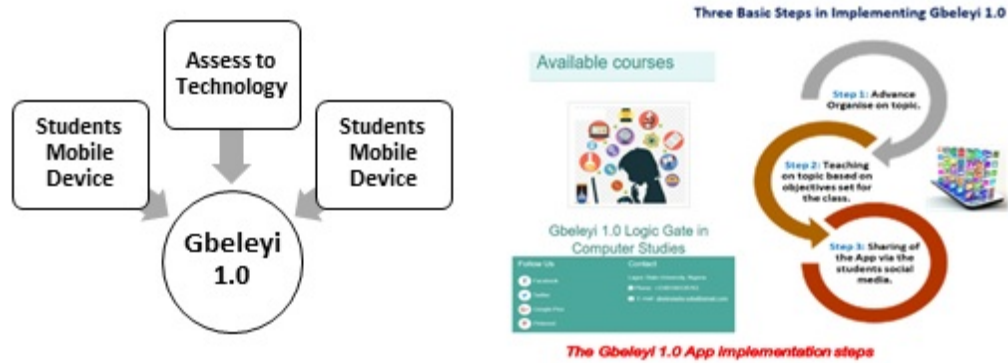


Figure 1. Gbeleyi 1.0 Mobile App and Learners in Secondary Schools

meaningful learning of science (Awaah, 2020). Barriers such as fear of science due to its special language and mathematical orientation; deficit of facilities for teaching and learning; abstract nature of some of the concepts; and perception that science is only for the gifted are melted and broken down by CTCA. The approach is an amalgam, drawing on the power of three frameworks:

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

The theory emphasises culture localisation as basis for understanding human behaviour and promoting learning.

The strength of CTCA is its combination of three frameworks which are known to be important in the learning process: culture, technology, and context. Teaching from the cultural and contextual perspectives of the learner and tapping the power of technology to deliver instruction are innovative as a combination of a single teaching tool. Within the context of CTCA being Afrocentric, the philosophical drive hinged on the works of Kwame Nkrumah's ethnophilosophy (1945) and Martin Heidegger's technophilosophy (1977 [1954]). Nkrumah's ethnophilosophy espouses knowledge rooted within the ethnic environs of people – Africa in this instance. The philosophy is reflective of the “culturo” and “contextual” dimensions of Culturo-Techno-Contextual Approach which admonishes teaching and learning based on one's cultural milieu.

Vygotsky's theory of social constructivism here provides a strong base for the establishment of Culturo-Techno-Contextual Approach. Before any lesson, students are directed to interact with parents, and relations or any adult on cultural practices or indigenous knowledge related to the content and to watch related videos on YouTube using their mobile phones. On getting to the classroom, the students share these findings among the group set up by the computer science/studies teacher with mixed abilities, and sex. This way, the students learn from interactions with their parents or relatives and through YouTube videos (More Knowledgeable Others - MKO). They also learn through interaction and scaffolding with peers and gradually, they move from their zone of can-do without help to a higher Zone of Proximal Development (ZPD) espoused by Vygotsky in Oladejo et al. (2022a).

The second theory base of the study is Ausubel's theory of advanced organizer. Ausubel (2000 [1963]) proposed the notion of an advanced organizer as a way of helping students link their ideas with new material or concepts. These more inclusive

concepts or ideas are advanced organizers (Bryce & Blown, 2023). 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 pre-lesson assignments) through metal scaffolding to foster deep or meaningful learning.

When CTCA is being implemented, students are engaged in activities that demand that they:

1. draw on their topic-relevant indigenous (cultural) knowledge;
2. use technology to seek pre-lesson knowledge of the topic to be taught;
3. work in groups to share knowledge gleaned from their socio-cultural interactions and web-based resources;
4. draw on their prior knowledge of the topic when class is in session and
5. relate lesson examples to their local contexts.

In seeking a theory base for CTCA based on the foregoing, which existing theory does the cap fit? With the five orientations of CTCA, it is obvious that several theories will “present their heads” to fit the CTCA theoretical framework cap. Two of these stand out. Orientations (a), (b), (c), and (e) of CTCA fit snugly with Vygotsky’s theory of social constructivism (?). Orientation (a) (d) and (e) relate well with Ausubel’s subsumption theory. So, here we have in our hands, two theory bases for CTCA (Figure 2).

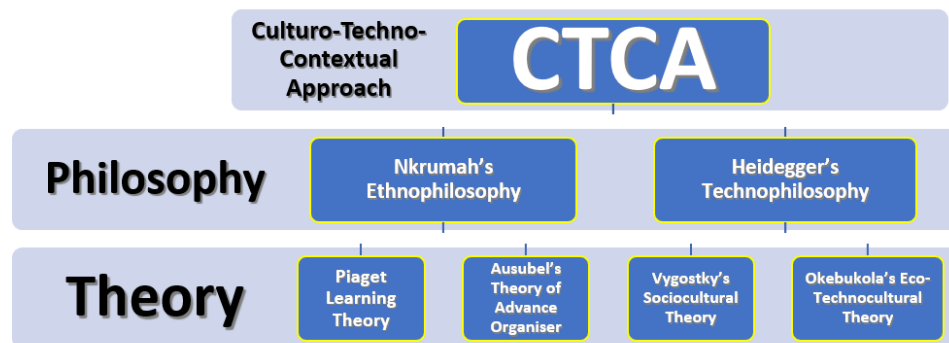


Figure 2. CTCA Theoretical frameworks. Source: Gbeleyi et al. (2022)

2.1. Procedure for Implementing CTCA

The procedure for implementing CTCA involves featuring the culture, technology and context frameworks in the delivery of every lesson. It follows a 5-step process (CTCA-Team, n.d.). These are:

1. Inform students ahead of time of the topic to be learned in class. Ask each student to reflect on indigenous knowledge or cultural practices and beliefs associated with the topic or concept. Students should be made aware that such reflections are to be shared with others in class when the topic is to be taught.
2. At the start of the lesson and after the introduction by the teacher, students are grouped into mix-ability, mix-sex groups to share individual reflections on the indigenous knowledge and cultural practices and beliefs associated with topic. All such reflections are documented and presented to the whole class by the group

leaders. The teacher wraps up by sharing his/her indigenous knowledge and cultural practices associated with the topic.

3. The teacher progresses the lesson, drawing practical examples from the immediate surroundings of the school. Such examples can be physically observed by students to make science real. This is one of the “context” flavours of the approach.
4. As the lesson progresses, the class is reminded of the relevance of the indigenous knowledge and cultural practices documented by the groups for meaningful understanding of the concepts. If misconceptions are associated with cultural beliefs, they are cleared by the teacher
5. At the close of the lesson, the teacher sends a maximum 320-character summary of the lesson (two pages) via SMS or WhatsApp to all students. After the first lesson, student group leaders are to send such messages. This is one of the technology flavours of the approach.

3. EMPIRICAL STUDIES ON THE EFFICACY OF THE CULTURO –TECHNO-CONTEXTUAL APPROACH (CTCA)

Several tools can be used to break barriers to meaningful learning, CTCA being one of them (Gbeleyi, 2020). By extension, CTCA is offered as one of the numerous tools in the toolkit of the teacher that can be useful in breaking these barriers. It can be explored if the goal is to promote meaningful learning. Anchored on studies spanning over three decades by Professor Peter Okebukola of the Lagos State University and his research teams, the CTCA was unveiled as an additional method to the existing methods of teaching and learning science (Gbeleyi, 2020). The CTCA argues that one of the key influences on pupils/students’ understanding of science is their cultural, traditional, or indigenous knowledge. The CTCA further proffers that, if the culture or indigenous knowledge of a pupil or student is the basis of teaching, the traditional barriers relative to understanding science will be broken. The CTCA further argues that students will better process scientific ideas through the lenses of their culture which will enhance understanding.

Literature on teaching methods and theories in recent times is bereft of African theorists. Yet, ample studies have shown that many students within the African region find some concepts difficult to study (Awaah, Arkorful, Foli, Darteh, & Yeboah, 2021; Awaah, Okebukola, Alfa, Anagba, & Arkorful, 2021; Awaah et al., 2020). Other studies in the sciences such as Abdulhadi, Awaah, Agbanimu, Ekwana, and Sefiamor-Heloo (2023), and Ademola et al. (2021) have equally found some concepts difficult for students to learn. These findings have implications for the quality of teaching and learning within the African region, with academic dishonest practices on the rise as a result of the difficulties in studying subjects among students (Awaah, 2019). These findings, coupled with other studies are pointers to indigenous methods as the preferred way to ensure quality teaching (Raheem, Anamuah-Mensah, & Sefa-Dei, 2014), necessitating a desk review of studies that have tested the CTCA in a bid to unveil the gaps in the theory/ approach towards an enhanced educational system within the African region.

Advocates of multicultural education (Chebanne & Gabanamotse-Mogara, 2022) and critically responsive pedagogy (Gay, 2010; Hammond, 2014; Hill, 2012; Ladson-Billings, 2009, 2021) have argued that black students and other minorities of color deserve a curriculum that validates their cultures in the classroom, just like we have in CTCA; others (Harushimana, 2022) have worked tirelessly on devising literacy pedagogies that are tailored to the needs and life experiences of black children all around the world. Unfortunately, schools of education show little inclination to include these pedagogies on the curriculum, and minority teachers who try

to incorporate culturally responsive pedagogy in their courses are likely to meet resistance from white teacher candidates (Mthethwa-Sommers, 2013; Seo, 2022). Hence, the major hurdle for black educators is that they are neither encouraged to join or stay, let alone to thrive, in the teaching profession (Harushimana, 2022).

In furtherance to this, other works within the COVID-19 pandemic reveal the importance of technology as an effective tool for teaching and learning especially within the African region (Okebukola, Onowugbeda, et al., 2020; Okebukola, Suwadu, et al., 2020). These findings further necessitate an examination of the efficacy of the CTCA since the 'T' component is relative to technology.

In the Onowugbeda (2020) study, he argued that it is possible integrating indigenous (cultural) knowledge in the biology classroom to support meaningful learning and cultural sustainability. Learning the concept of sustainability is essential to learners' future, thus, integrating indigenous knowledge is required to link the space and gaps that occur in the mind of students. Indigenous (cultural) knowledge helps students think on the advocates of life and protect nature and culture from over-exploitation.

Onowugbeda et al. (2022) supports this indigenous trend by positing that the poor performance of students in biology over the years is worrisome. This may be traced to the content knowledge of biology teachers and the level of assimilation and understanding of biology concepts by the students. To mitigate these, the role of culture, norms and activities of any community cannot be neglected if a nation aspires to create an educational system that fosters development.

Odekeye (2020) further observed that indigenous (cultural) knowledge is important for both local communities and the global community. Thus, curriculum developers in biology need to recognise the role of indigenous (cultural) knowledge, understand its workings in the context of local communities, and systematically integrate it into the development programmes they design for effective teaching and learning.

Although Abdulhadi et al. (2023) sample size does not permit wide generalisations, the findings suggest that biology teachers should explore the use of the CTCA in improving the achievement of students in scientific explanations, especially in genetics and ecology. Like the Saanu (2015) in study, this research also did not report on a pre-test and a retention test. This, as mentioned earlier, precludes researchers from deducing whether the method is effective or the students performed rot rather than deep learning for the post-test.

Further, in a survey of 60 Senior Secondary Three biology students on the potency of the CTCA on students' achievement and attitude towards mutation and variation in Biology, Adam (2019) found that there was a positive impact of the CTCA as pieces of evidence showed the experimental group students performed better than the control group students on the achievement measure and attitude towards mutation and variation.

4. PROCEDURE

With the introduction of the 6-3-3-4 system of education in Nigeria, the recipient of the education would spend six years in primary school, three years in junior secondary school, three years in senior secondary school, and four years in a tertiary institution. The six years spent in primary school and the three years spent in junior secondary school are merged to form the nine in the 9-3-4 system. Altogether, the students must spend a minimum period of six years in Secondary School. During this period, students are expected to spend three years in Junior Secondary School and three years in Senior Secondary School.

A mixed-method design was adopted for data collection. First, the study employed a survey design to elicit information from the students regarding which topic in the new computer studies curriculum they found difficult, why so, and suggestions for

improvement. The survey had 1,501 Senior Secondary computer studies students (male=734, female=767) in Nigeria and Ghana. The topic ranked as one of the most difficult among the 19 concepts was "Logic Gate", which was selected for the second phase. The participant's next phase was 213 Juniors Secondary School Two (JS)¹ who, at the time of the study, had not taken the Basic Education Certificate Examinations (BECE) (*Welcome to Lagos State Examinations Board. Online Portal, n.d.*) to ascertain the level of potency of the methods in question. The schools in Education Districts in Lagos State were randomly selected; about 62% of the respondents were females while about 38% were males. The teaching methods: CTCA, Gbeleyi 1.0, and lecture methods were used to measure the performance and critical thinking skills of students in the logic gate. A pre-test and post-test consisting of the achievement test and Critical Thinking Skill task were administered to all groups. Participants in the experimental groups were exposed to CTCA and Gbeleyi 1.0 instruction, while the control group was exposed to the same content using the traditional lecture method.

The instrumentations for the studies were as follows: Logic Gate Achievement Test (LGAT) (Appendix A), Critical Thinking Skill Task (CTST) (Appendix B), and Students' Perception of the CTCA interview guide (SPCIG) (Appendix C). These instruments whose reliability and validity exercises were conducted by experts in the Africa Centre of Excellence for Innovative and Transformative Stem Education (ACEITSE), and Science and Technology Education (STE) department of the Lagos State University (LASU), and two computer studies teachers at with experience of over ten years teaching and marking of west African examination council (WAEC) and Basic Education Certificate Examinations (BECE) scripts. A respectable reliability coefficient of 0.78 and 0.74 were obtained respectively. Data collection took six weeks while analysis was carried out using IBM SPSS version 23. The experimental and control classes were subjected to pre-test and post- test using the same instruments. The implementation of CTCA for teaching logic gate followed the five-step CTCA protocol (Figure 3):

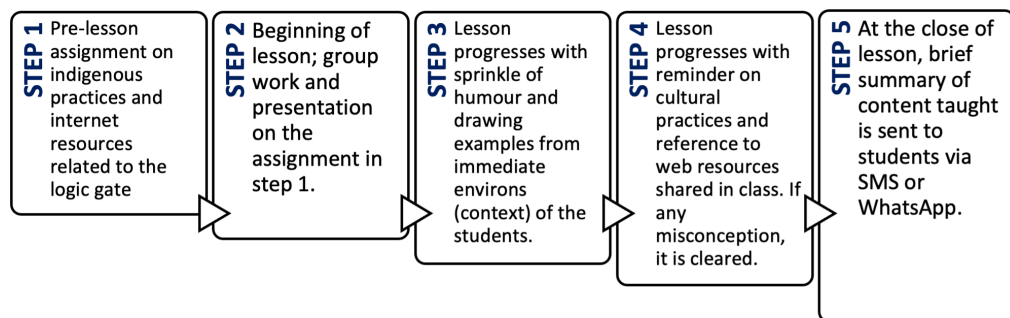


Figure 3. Implementation of CTCA steps in the classroom. Source: Gbeleyi et al. (2022)

5. ANALYSES AND FINDINGS

The data collected were analysed using descriptive statistics, percentages, and standard deviation to ensure organization and description of the characteristics of some of the data collected. The multivariate analysis of covariance (MANCOVA) was used to test for statistical differences at a confidence level of 0.05. The experimental phase entailed data generated from the logic gate achievement test and critical thinking skills task which were analyzed using IBM - SPSS 23.

¹ISCED level 2 – Lower secondary education (UNESCO, n.d.)

Findings from the study revealed that there was a statistically significant difference in the achievement and critical thinking skill tasks of students taught Logic Gate and those taught with lecture method using the CTCA and Gbeleyi 1.0 (Figure 4). Based on the results, the null hypothesis is therefore not rejected. The multivariate F (Pillai's Trace) was significant [$F=17.67$; $p<.04$], univariate ANOVA on achievement [$F(2, 208) = 20.67$; $p<0.05$]; and critical thinking skills [$F(2, 208) = 15.14$; $p<0.05$] as revealed in Figure 4. This result shows consistency with the findings of Fong, Kim, Davis, Hoang, and Kim (2017). In meta-analysis on critical thinking and community college student achievement from a total of 23 studies (27 samples, $N = 8233$) it was established that critical thinking was moderately related to community student success. The relationship between student achievement and levels of critical thinking was constant for students as well as for grades and individual test outcomes. The results of Kamran, Naeim, Mohammadi, and Masoumi (2022), also showed a higher score for critical thinking among converging people than among assimilating, accommodating, and diverging people. Unlike the findings of these studies, Ghazivakili et al. (2014) found that the total score of critical thinking differed among the four learning-style groups and that two of the subscales of critical thinking (evaluation and inductive reasoning) were positively related to learning styles.

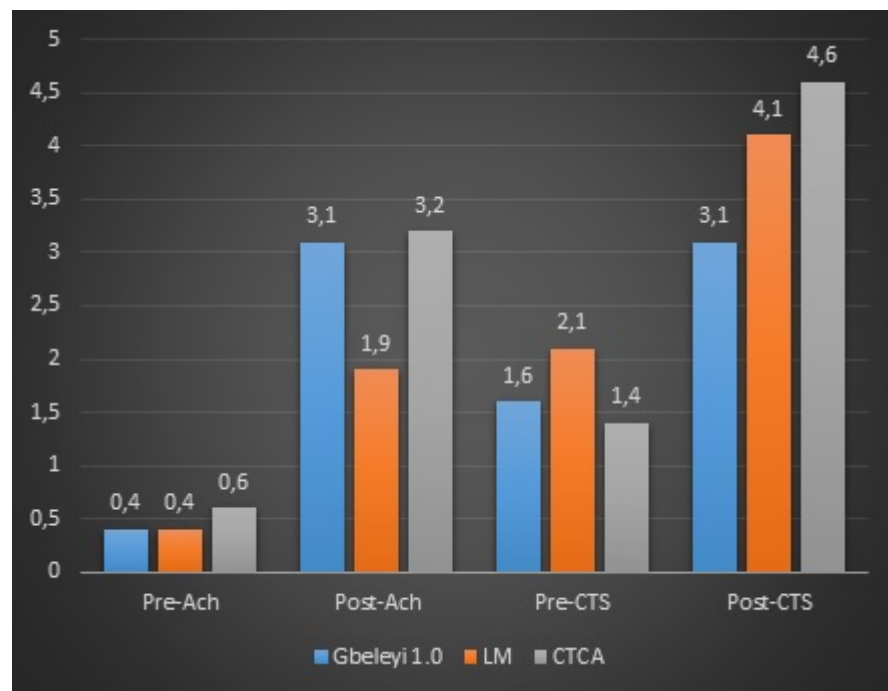


Figure 4. Summary of the Mean Scores on Teaching Methods on Achievement & CTS

Table 1. Selections of Interviews on Students' Perception of the Use of CTCA

Pseudo Name	Note all data are reported unedited
B	‘The CTCA has helped me understand concepts such as truth table output variables which initially seemed difficult.’
D	‘Am very happy to relate the concepts in logic gate to my environment due to the cultural examples given by the teacher’.
J	‘We are grateful for this help and I like the teaching method. Thank you, sir’.
T	‘The use of cultural examples made it easier for me to understand and interesting’.

The perception of the students which were randomly selected was highlighted in the Table 1, as the qualitative aspect of the study. From the study, examples of indigenous knowledge related and found applicable to the teaching of Logic Gate include; eja ojiji “electric fish”, serial and parallel arrangement of weeds or crops on the farmland, marble stones “ako okuta” to spark a fire in burning weeds, mimosa pudica “ewe padimo”, “ogusho” to light or ignite a fire in the absence of kerosene, petrol or gas, and the save game played by the children in schools (Figure 5). All these, are what is used in comparison with the modern technology or electricity effect of the Logic Gate.



Figure 5. Indigenous Knowledge illustrations used in Teaching of Logic Gate.

Source: Gbeleyi et al. (2022)

6. RELATE CRITICAL THINKING TO STUDENTS' ACADEMIC PERFORMANCE

Today's students need support in not only developing capacity for a global mindset, but also for thinking critically about the world globally. Employers are seeking graduates who can enter the labor force prepared to work within industries with the ability to understand its complexities. Higher Education Institutions (HEIs) have been called upon to provide this to students and faculty are often charged with this responsibility.

Therefore, critical thinking skill is one of the most important types of thinking that requires realization in the educational process, especially in the age of information age, so that the student becomes a critical thinker that rise above the circle of imitation and negative dependency. Critical thinking has become one of the goals of the modern educational process. That is why researchers have paid more attention to critical thinking. Its models have varied, such as Beyer Model, Ennis Model, Delphi Expert Model, and Watson and Glaser Model. Critical thinking is defined by Facione “a purposeful, self-organizing judgment that leads to interpretation, analysis, evaluation, and inference, as well as an explanation of the evidence, concepts, methodology, standards, or contextual considerations upon which this judgment is based”(1990, 2)

Literature suggested that critical thinking ability is a scientific ability that is essential and is a goal in learning science (Huber & Kuncel, 2016). Agree with that, the scientific critical-thinking skill is an ability possessed by students used in solving scientific problems (Liu, Frankel, & Roohr, 2014). The critical-thinking skill in computer studies can also be interpreted as the ability to include prior knowledge (Schoenfeld, 1992), cognitive strategies to generalize, prove or evaluate scientific situations which include: testing, questioning, connecting every aspect that exists in scientific problems (Greenwald & Quitadamo, 2014). The uniqueness and complexity of the elements in computer

studies or science require learners to be able to think critically in learning them. Also, it was explained that the scientific critical-thinking skill is a high-level thinking process that can be used in the formation of systems or students' conceptual students' academic performance (Taube, 1997).

7. SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study carefully highlighted the relevance and importance computer studies to humans from different perspectives. It emphasized the need to reduce or remove the difficulties that students encounter in learning computer studies which often arise from teaching in abstraction and inability of the teacher to provide local examples available within the immediate environment of the learners and how this can easily be overcome by harnessing the power of indigenous knowledge with current classroom practices.

With the call for culturally and contextually responsive teaching pedagogies to help break the traditional barriers to meaningful science learning, several teaching methods have been developed and explored in response to this call. This array of teaching methods has recorded some gains and was at least, helpful in the acquisition of factual scientific knowledge. However, to achieve the “Africa we want” as detailed in the African Union Commission’s agenda 2063 (AUC, 2015), African students need science learning that thrives beyond memorization of scientific facts, to one that affords them the strength to meaningfully learn science in the digital world (Oladejo et al., 2022b).

This study will help towards achieving equity in science learning—presenting challenges for learners in modeling practices— such as constructing a model that can aid their sense-making, and seeing model construction five steps of CTCA as a way to generate new knowledge rather than represent what they have already learned (Schwarz et al., 2009). In a study on the extent of CT’s and ICT literacy in Ethiopia’s secondary school (Grades 9–12), the analysis revealed that CT was incorporated into the curriculum through the use of Logo, Excel, and multimedia projects; The integration could not however be described as “systematic” (Kassa & Mekonnen, 2022). Therefore, there is need to incorporate more diversities like we have in the CTCA for meaningful learning to take place within the context of the learners.

Students will usually translate concepts from the known to the unknown. It reflects why students will understand concepts taught in schools when traditional examples related to their environs are used as the basis for teaching. This reasoning has proven true with the four studies reported on. The Culturo-Techno-Contextual Approach has proven effective so far with studies carried out within the African region. Based on these successes, there is a need to (a) continue testing the invention on many subjects within the African region; (b) there is need to test the efficacy of the invention with larger samples to establish its generalisability or otherwise (c) other regions of the world need to test the invention to establish its efficacy or otherwise. The CTCA has largely been tested within the African region. It will be novel to test the efficacy of the theory in other regions of the world to compare outcomes of the model.

A. APPENDIX. LOGIC GATE ACHIEVEMENT TEST (LGAT)

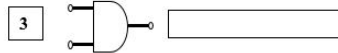
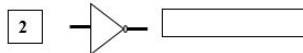
[Logic Gate Achievement Test]

LAGOS STATE UNIVERSITY, OJO
Africa Centre of Excellence in Transformative STEM Education –
Achievement Test to Logic Gate

School: Sex: Age:

1. Define of logic gate

Differentiate the logic gates below with the number of input variable: (2) & (3)



Complete the following truth tables for No. (4), (5) & (6)

4

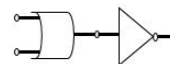
AND GATE		
A	B	Q
0	0	
	1	
1		
1	1	

5

NOT GATE	
A	Q
1	

6

OR GATE		
A	B	Q
0		
0	1	
1	0	
	1	



(7). Construct the truth tables that reflect the following logic gates

(8). The output is "true" when both inputs are "true." Otherwise, the output is "false." What gate is being refer to here _____

(9). It has only one input. It reverses the logic state. What gate is being refer to here _____

(10). Interpret the Boolean expression AB with a truth table.

B. APPENDIX. CRITICAL THINKING SKILL TASK (OCTST)

Critical Thinking Skill Task (OCTST)

Dear Student,

The purpose of this test is to assess how quickly and deeply you can think in order to provide solutions to problems. This is neither a quiz nor a test. The results will be anonymous and will have no impact on your success in class. As the results will help us to find strategies to improve your critical thinking skills, try to be sincere in your answers. So, feel free to respond to the best of your ability. Thank you.

Tel: 08184126763; Email: gbeleyiadio.edu@gmail.com

SECTION A: Demographic

1. Name:
2. Name of school.....
3. Location: Urban (.....) Rural (.....)
4. School type: Public (.....) Private (.....)
5. Class:
6. Sex: Male (.....) Female (.....)
7. Age: 12-14 years (.....) 15-16 years (.....) above 16years (.....)

SECTION B: Situations and questions

Time: 40 minutes

Instruction: Consider these situations and answer the questions that follow.

- 1) After flushing, the water in a toilet bowl continues to run and the reservoir no longer retains water. What should be done to stop the water and restore regular flow?
- 2) A relation who has observed all protocols contracts Covid-19 and is in intensive care. Not been a medical doctor, speculate on how he contracted the disease.
- 3) The kidnappers of a relation phoned asking for ransom. What are the safest lines of action?
- 4) A traveler who is lost in a desert has half a bottle of water left. He is about four days away to the nearest settlement. What action should he take to prevent death due to dehydration?
- 5) In a hut in a village, the water in a pot was found to be cooler than one in a refrigerator. How do you explain this?

C. APPENDIX. STUDENTS INTERVIEW GUIDE (SPCIG)

[Students Interview Guide (SIG)]

LAGOS STATE UNIVERSITY, OJO
Africa Centre of Excellence in Transformative STEM Education –

Students Interview Guide (SIG) on Impact of Culturo-Techno Contextual Approach (CTCA), Gbeleyi 1.0 on Students' Critical Thinking Skills and Attitude to Logic Gate

SECTION A

- Name of school:
 - Sex:
 - Age:
 - Class:
-

SECTION B

- Question 1: Do you like the method or the way your teacher taught the lesson?
- Question 2: Can you recollect/remember or apply what you have learnt after the lesson?
- Question 3: Do you like the concept of CTCA to be used in other subjects?
- Question 4: Can you relate comfortably with other members of the class?
- Question 5: Does your teacher explain the topics well by using instructional materials?
- Question 6: Do you have a standard laboratory for computer studies?

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