West African Journal of Open & Flexible Learning
Volume 11, Number 1, 2022

Culturally Relevant Pedagogies in Enhancing Students Learning of ICT Concepts: A Test of the Efficacy of CTCA

Les pédagogies culturellement pertinentes pour le renforcement de l'apprentissage des concepts de TIC par les étudiants : Un test de l'efficacité du CTCA

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Abstract

The study is concerned with the persistent underperformance of secondary school students in Nigeria in Information and Communication Technology (ICT). It was conducted in response to the ever-growing call on culturally relevant and contextually responsive pedagogies in African classrooms. A quasi-experimental research design was adopted with a total of 217 SS2 students from two schools in Lagos State education district V. The control group, taught with the lecture method, had 112 subjects (64 males; 51 females) while the experimental group, taught with Culturo-Techno-Contextual Approach (CTCA), had 105 subjects (49 males; 56 females). Both groups had a pretest and a retention test using the achievement test in the programme development circle (PDC) instrument. Treatment lasted four weeks. The data collected was analysed using one-way ANCOVA since intact classes were used. The result obtained showed that the experimental group *performed better (mean for experimental = 20.31; control 15.54; [F(1,214)=103.96; p<.05]) than the control group. Possible reasons for this difference were highlighted and we recommended CTCA as a viable tool for ICT teachers. Overall, we concluded that if well implemented, the CTC approach can help to promote meaningful learning of ICT concepts among secondary school students in Nigeria.*

Keywords: ICT; Culturally relevant pedagogy; Culturo-Techno-Contextual Approach; Meaningful learning.

Résumé

L'étude porte sur la sous-performance persistante des élèves de l'enseignement secondaire au Nigeria dans le domaine des technologies de l'information et de la communication (TIC). Elle a été menée en réponse à l'appel sans cesse croissant en faveur de pédagogies culturellement pertinentes et contextuellement réactives dans les salles de classe africaines. Un modèle de recherche quasi-expérimental a été adopté avec un total de 217 étudiants SS2 de deux écoles du district éducatif V de l'État de Lagos. Le groupe de contrôle, enseigné avec la méthode des cours magistraux, comptait 112 sujets (64 hommes ; 51 femmes) tandis que le groupe expérimental, enseigné avec l'approche culturo-techno-contextuelle (CTCA), comptait 105 sujets (49 hommes ; 56 femmes). Les deux groupes ont été soumis à un prétest et à un test de rétention à l'aide de l'instrument " test d'évaluation des acquis dans le cercle de développement des programmes " (PDC). Le traitement a duré quatre semaines. Les données recueillies ont été analysées à l'aide d'une ANCOVA à sens unique, puisque des classes intactes ont été utilisées. Les résultats obtenus montrent que le groupe expérimental a obtenu de meilleurs résultats (moyenne pour le groupe expérimental = 20,31 ; contrôle 15,54 ; [F(1,214)=103,96 ; p<0,05]) que le groupe de contrôle. Les raisons possibles de cette différence ont été mises en évidence et nous avons recommandé l'ACCS comme outil viable pour les enseignants en TIC. Dans l'ensemble, nous avons conclu que si elle est bien implantée, l'approche CTC peut aider à promouvoir un apprentissage significatif des concepts de TIC parmi les élèves de l'enseignement secondaire au Nigéria.

Mots-clés : TIC ; pédagogie culturellement pertinente ; approche culturo-techno-contextuelle ; apprentissage significatif, écoles secondaires

Introduction

Given the increasing incursion of modern technologies in every human activity, the knowledge and practical application of the Technology 'T' component of STEM concepts play a crucial role in human and national development. The knowledge and application of ICT concepts can be seen at the centre of many efforts geared towards fostering the growth and socio-economic development of any nation (Olawuwo, 2016). In school settings, the knowledge of ICT at the basic level translates into the understanding of how science and technology work which, in turn, stimulate learners' interest in the design and development of innovative technologies that can accelerate the growth and development of a nation (Agbanimu et al., 2022). In spite of this importance and the rapid rise in ICT start-ups and enterprises authored and owned by Africans over the last ten years, Africa still lags behind other regions of the world on several measures of ICT use including internet penetration, software and hardware development aimed at solving problems facing human security in Africa and the rest of the world. This creates a knowledge gap which needs to be bridged as quickly as possible to entrench the thrust of diversity, equity, inclusiveness and respect to the digital world. To level the playing field and bridge the digital divide sustainably, all efforts should prioritize schools in formal and informal settings as the nursery for spawning future computer scientists and engineers (Bovée, Voogt, & Meelissen, 2007; du Plessis & Webb, 2012; Koorsse, Cilliers & Calitz, 2015) with the provision of rich contents curriculum in ICT.

Between 1997 and 2014, Nigeria and most other African countries developed and implemented computer studies curricula for use in schools (Britz, & Boekhorst, 2004; Bovée, Voogt, & Meelissen, 2007; Okebukola, 2012). These curricula were structured around the three levels of education- the primary, the secondary, and the higher education levels. At the secondary school level, the goal of the curriculum is to provide historical development and key issues in recent advances in ICT with sprinkle of key ICT concepts such as basic programming, algorithm, networking, and logic. This level of knowledge exposure is adjudged by the developers to be enough requisite to whet the brains of the future computer scientists. At the higher education level, the goal was to produce specialists in software and hardware development and engineering. While these efforts have translated into some gains, experts' assessment of technological advancement in Nigeria shows that the gains are far from the success stories recorded in other regions of the world (Hart & Laher, 2015). Undoubtedly, Africa can be spawned for more impressive gains.

However, several challenges have been identified to hinder the effective and quality delivery of the provisions of the computer studies/ ICT curriculum in Nigeria and other African countries. According to Hennessy et al. (2010), the primary enablers and barriers to ICT integration in the classroom are teachers' beliefs and attitudes towards the use of ICT. Other challenges include teachers' pedagogical content knowledge and skills (Yadav & Berges, 2019; Mtebe & Raphael, 2018; Chukwuemeka et al., 2019), lack of contextually appropriate course content (Gbeleyi et al., 2022), unavailability of learning resources or facilities (Oladejo, 2018), and the inept teaching approaches used in delivering the curriculum contents to the students (Agbanimu et al., 2022; Oladejo, Akinola and Nwaboku, 2021). These factors as a whole or individually, determine how effectively and efficiently the predetermined learning objectives of the subject' contents are achieved.

The teacher's choice of teaching approach plays a crucial role in the attainment of the desired teaching and learning objectives; teachers need it as a tool to teach effectively and students need it to learn meaningfully (Oladejo, 2018; Okebukola, 2020). The teaching and learning of computer studies/ICT require practical applications and activity-based experiences of computer processes as against rote learning of the concepts. However, the approach used in teaching computer studies/ICT in African classrooms particularly in Nigeria, since the start of the subject does not prioritize the use of learning resources that facilitate practical learning experiences. Thus, topics in the subject are being taught as abstract concepts and this poses a difficulty for students in understanding even the basics of the subject (Peter, 2020). In 2020 a group of researchers led by Okebukola took the bull by the horn, to survey topics/concepts in ICT found difficult to learn by senior secondary school students in Nigeria and Ghana since both countries operate the WASSCE syllabus.

According to the report, networking, flowcharting, programme development cycle, algorithm, logic gate, basic programming, and machine language topped the list of topics/concepts that students find difficult to learn. To our dismay, these concepts are what students are expected to learn at the senior secondary school level across the Anglophone West African countries because the contents of these topics/concepts form the lion share of questions in the West African Senior School Certificate Examinations (WASSCE) and by extension the NECO-SSCE on yearly basis. A quick glance at the WASSCE chief examiner's report revealed that in the last five years, candidates have shown lack of adequate knowledge in and good understanding of these concepts. Available statistics (Gbeleyi et al., 2022) on students' performance in ICT in Nigeria (2013-2018 WASSCE summary) also reveals poor performance of the students which may translate to lack of adequate knowledge in and understanding of these concepts (see Table 1).

Table 11: Performance of Students in ICT at SSCE Level from 2013 to 2018

Year	No of students present	No of students pass	No of students fail	% pass	% fail
2013	182659	39125	143534	21	79
2014	228953	80355	148598	35	65
2015	250099	86150	163949	34	66
2016	289520	84520	205000	29	71
2017	326541	98215	228326	30	70
2018	367562	120560	247002	33	67

Source: WAEC Office (2018)

Probing further to the specifics of the difficulties that students have with learning these concepts, the students' responses from the survey (Okebukola et al., 2020) indicate that the difficulty was largely associated with inability to relate what they were taught in class with their immediate surroundings as in the case of their experiences in biology. Thus, the students perceived these concepts as culturally and contextually irrelevant. On this note, we conjectured that the inability of the students to relate their classroom activities with their socio-cultural realities as espoused by Ausubel (1963), theorized by Ladson-

Billings (1995), Jophus (2020) and attested to by Okebukola (2020), may have been the major cause hindering the students from meaningfully learning these concepts.

To respond to this indication and ensure that the students find these concepts exciting, easy to learn, gain meaningful knowledge and practice and improve their academic achievement, there is an urgent need to explore the relevance of culture and context in the teaching and learning exercise. This was the impetus for considering the Culturo-Techno-Contextual Approach (CTCA), a teaching strategy which explores the richness of African culture (indigenous knowledge), the role of technology in teaching and learning (techno) and the locational context (contextual) of the learners, as a suitable fix.

The Culturo-Techno-Contextual Approach (CTCA) leverages the importance of culture (indigenous knowledge), in cognitive development, the role of technology in teaching and learning and the locational context of the learners to enhance learning activities, arouse learners' interest in learning and improve students' academic achievement. The value of indigenous knowledge as a form of rational and reliable knowledge is becoming increasingly recognized and appreciated by science scholars and educators (Okebukola, 2020). Scientific practices and techniques of farming (irrigation, storage), medicine (bone-setting), clothing, and security have cultural lineage that were available in somewhat similar forms across different cultures of the world, particularly in Africa (Akintola 2020, Jophus, 2020). Such knowledge system helps to sustain the livelihood of the indigenous people and as such considered as much relevant as the modern (western) scientific knowledge system. Explicitly, Kola-Olusanya (2020) asserts that modern science is a product of cultural knowledge and practices and can only be best taught, learnt, and understood in relation to its tenets.

In teaching and learning, the first component of the CTC approach, cultural/indigenous knowledge, establishes a significant connection between what students learn in school and their lives beyond school, making it easy for students to construct their knowledge which manifests into meaningful understanding (Angaama, Fatoba, Riffel &

Ogunniyi, 2016). According to Gbamanja (2014), the use of cultural knowledge system in science teaching boosts the achievement of secondary school students in STEM concepts. In addition, some recent studies (Bogopa, 2012; Moloi, 2013; Mudaly, 2018; Naidoo, 2021) channeled towards improving the performance of students in mathematics and/or any concepts in science involving calculations have shown that the use of indigenous knowledge and indigenous games in teaching and learning of mathematics are modifiable factors. The findings of these studies summarily express that teaching and learning of some traditionally perceived difficult concepts in science and mathematics were made easy using cultural or indigenous knowledge.

Beyond helping students to gain meaningful learning and understanding of STEM concepts and scientific processes, culturally responsive pedagogies have also been observed to help students develop positive self-concept/self-perception as capable learners who belong in STEM (Bustos-Works et al., 2021). This is evident in their ability to contextualize learning, allowing students to explore their immediate environment and relate their day-to-day activities and ways of life to classroom learning and activities. More so, research have shown that science teaching approach that supports the use of local and context-based illustrations to concretise learning, brings science nearer to the students and promotes meaningful understanding (Fakoyede and Otulaja, 2020; Pobiner, 2019)

The role of technology (the second component of CTCA) in promoting meaningful learning in and outside the four walls of the classroomis also indispensable . Today's learners have been found to often employ the use of social media and web resources such as YouTube, Wikipedia resources, WhatsApp, Facebook, and so on for their learning activities (Okebukola et al., 2016). These sources provide learners with a wide range of information and also have the potential to arrest and sustain learners' interest in learning which will, in turn, promote the acquisition of meaningful learning, and improve students' achievement in the topic or concept being taught. CTCA takes advantage of students' frequent use of these sources to enhance teaching and learning activities.

The third component of the CTCA which is the use of contextually-relevant examples in the classroom to exemplify and simplify difficult concepts in science and technology have also been found very effective in enhancing students' achievement and retention (Saanu, 2015; Okebukola et al., 2016; Adebayo et al., 2022; Oladejo, 2020; Agbanimu, 2020). Using physical objects, events, or situations existing within the locational context of the learners or the school environment as an illustration helps to concretise learning and removes the abstract nature of STEM concepts which is associated with rote learning.

CTCA is conceived as a learner-centered approach as it actively engages learners in the learning process and gives every students the opportunity to contribute to the body of knowledge. Learning is fun with CTCA because as learning progresses in the classroom the teacher is expected to sprinkle a tinge of humor to ensure that the lesson is free from boredom and to make the students feel happy to learn (Oladejo et al., 2022). Giving examples that can be seen, felt or experienced within the locational context of the leaners removes the abstract nature of some science concepts and makes learning real. This approach targets difficult concepts in STEM as well as other subjects in order to promote meaningful learning (Okebukola, 2020)

However, due to the novel nature of this approach, very few studies have documented the potency of the approach on students' academic achievement in ICT. It is based on this background that this study is conceived to explore the efficacy of the Culturo-Techno-Contextual Approach on students' achievement (retention) in program development cycle (PDC)– a perceived difficult concept in computer studies. The most recent survey of difficult concepts in computer studies (Okebukola et al., 2020) reported this concept as the fourth most difficult concept in computer studies. More so, it appears that this concept takes a large proportion of the ICT questions in the West African Examination Council (WAEC) assessments on yearly basis. These conditions are the rationales for our choice of the concept.

Research questions

1. Will there be a significant difference in the achievement (retention) of senior secondary students taught PDC using CTCA and those taught with lecture method?
2. What impact will CTCA have on the achievement (retention) of male and female students in PDC?

Theoretical framework

The theoretical framework for this study draws from Vygotsky's theory of social constructivism and instructional scaffolding and Ausubel's theory of meaningful verbal learning and advance organizer. Vygotsky (1962) argues that culture is the primary determinant of knowledge processing and construction. Learning takes place through social interaction among the people bound by culture created by their unique strengths, language, and experiences. Moses (1992) corroborating this argument asserts that learning as human behavior is rested on interaction with significant others within the social environment influenced by the culture of the people. This significance of culture in knowledge formulation is what CTCA leverages.

Vygotsky's theory of social constructivism further asserts that learning is essentially a social process where important roles are played by parents, teachers, peers, culture, and the society at large. The theory emphasizes social interaction within the family and with knowledgeable others in the society as the basis for a child's acquisition of knowledge and behavior that are relevant to the society. This assertion provides support for the implementation of CTCA. A step in the implementation of CTCA requires the students to seek information about indigenous (cultural) knowledge related to a given topic from their parents, guidance, or any more knowledgeable other (MKO) before coming to class. This process exhibits social interaction with parents playing a crucial role in the development of higher psychological functions of the students. The pre-lesson knowledge obtained from this interaction serves as an advance organizer (Ausubel, 2012) making it easier for the students to incorporate new information into their cognitive structure during the main lesson. From Ausubel's perspective, this is meaningful learning. The notion of an advanced organizer was proposed by Ausubel as a way of helping students to learn meaningfully rather than rote learning by linking their ideas with new information, concepts, or materials.

CTCA also allows the students to work in groups (mixed-sex and mixed-ability) to share among their peers the knowledge gleaned from their socio-cultural interactions with parents and other resources. This strengthens the social process of interacting with classmates (peers), enabling the students to share and gain knowledge that ordinarily they may not have gained independently. According to Vygotsky, this structure of learning (scaffolding) provides support for a student to learn skills or aspects of a skill that go beyond the student’s zone of proximal development (ZPD). The ZPD, as defined by Vygotsky, is the set of skills or knowledge a student cannot do on his/her own but can do with the help or guidance of a more knowledgeable other (MKO). The theory behind these concepts (scaffolding and ZPD) which explains their underlying connection with this study is that, compared to learning independently, CTCA allows the students to learn more when collaborating with their peers or others who have a wider range of knowledge and skills than they currently do. Also, the use of ZPD requires the teacher to know the current level of knowledge of the students and that is the thrust of the pre-lesson activities in CTCA.

Methods

The study employed a quasi-experimental research design which involved quantitative data gathering techniques; a pretest, posttest, post-posttest non-equivalent group design involving experimental and control cases

Participants - All senior secondary school students offering computer studies/ICT in Lagos state education district V made the population for this study. Two schools were purposively selected for the experimental and control groups. The rationale for purposively selecting the schools was to ensure that the schools have computer studies/ICT teachers with consistent records of teaching and learning of the subject for at least two academic sessions (or years), including the academic session when this study was conducted. Also, we ensured that the schools were far away from each other to avoid undue interaction between subjects of the groups which may confound the result of the study. A total of 217 senior secondary school year two students (SS2) drawn from two intact classes in the selected schools made the sample for this study. The control class had 112 subjects (64 boys, 51 girls) while the experimental class had 105 subjects (49 boys, 56 girls). These set of students were considered appropriate for this study given their exposure to the requisite knowledge for learning program development cycle (PDC) while they were in SS1. We chose PDC because it is a basic knowledge for most innovations in ICT and the tech-world.

Instrumentation **-** Program Development Cycle Achievement Test (PDCAT). The PDCAT was used to test the students' understanding of the concepts in PDC before and after they were exposed to treatments. PDCAT was designed into two sections; section A sought the demographic information of the participants, while section B had a total of 30 discreet (multiple choice) questions, developed using the specifications of the revised Bloom's taxonomy of educational objectives (Anderson and Krathwohl, 2001) with four options lettered A-D. The questions were structured in alignment with two validated achievement question inventories; the West African Senior School Certificate Examination past questions and two commonly used senior secondary school computer studies textbooks, ensuring that all predetermined learning objectives were measured.

The validation of the PDCAT was done by three ICT teachers with over 8 years of experience in teaching the subject at senior secondary school level. It was prudent to ensure that these validators are very converssant with the coordination and marking of the WASSCE and NECO computer studies for over five years as their role was to ensure that the contents of the instrument was in line with what the students were expected to learn. In order to ensure the validity of this instrument, the services of two secondary school English Language teachers with over five years of working experience were also employed to check and correct any grammatical or semantic errors that may be present in the instrument. All comments and observations were resolved accordingly before the instrument was subjected to reliability measure. To determine the reliability of the instrument, the PDCAT was administered to 54 students, who were not part of the participants for this study. The scores were analysed using the split-half stability test procedure and we obtained a reliabilty coefficient of 0.76 for the instrument.

***Study Procedure* -** Following the permission to conduct the study, we conducted pretest for both the experimental and control groups using the PDCAT. Two days after the pretest, we commenced the treatment. The experimental group was treated with CTCA while the control group was taught using the conventional lecture method. The treatment lasted for four weeks for both groups. We were careful not to obtain results that are biased based on teacher factor, hence, we let the teachers of each group conduct the teaching exercise. However, the teacher of the experimental class was trained on how to implement CTCA in a typical classroom. After a week of training, the teacher was subjected to a microteaching, to assess the mastery of the implementation procedure. How then was CTCA implemented during the treatment? The teaching and learning of PDC in the experimental class followed the 5-step implementation procedure of CTCA in the classroom (Okebukola, 2020).

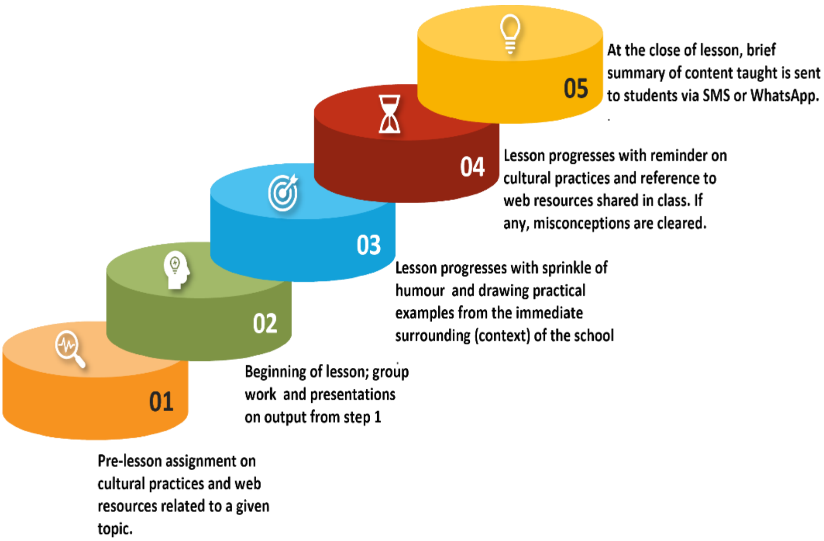

Figure 1: The five steps of CTCA at a glance (Okebukola, 2020)

Two days before the first lesson, the teacher informed the students of the topic to be learned and issued a pre-lesson assignment. Each student was asked to: (a) reflect on indigenous knowledge or cultural practices and beliefs associated with the topic; and (b) they were instructed to search the web for resources relating to PDC using their mobile phones or other internet-enabled devices. They were told to discuss the assignments with their parents/guidance or anyone who could help them at home on the indigenous knowledge or cultural practices. They were also informed that such reflections will be shared with others at the beginning of the lesson; this was **step 1.**

At the beginning of the lesson, the teacher introduced the topic and afterwards, he grouped the students into mixed-ability and mixed-sex groups of eight to ten students per group with a group leader. Each student in a group was asked to share with the group members what they got from the assignment given to them. The group leaders of each group were then asked to present the submissions of each student in their group to the whole class within 3 minutes each. At the end of all presentations, the teacher wrapped up by sharing his own perspectives. Examples of cultural practices used to exemplify the basic seven (7) phases of PDC which are problem definition, program design, coding, debugging, testing, documentation and maintenance include: cooking of native Yoruba soup (efo riro); hunting; selection and coronation of kings (using Ife land as a case study); the Blacksmith, and fishing techniques (using netting as a case study). This was **step 2.**

As the lessson progressed, the teacher provided practical examples which were drawn from the school environment. The teacher also ensured that the class was interactive with sprinkles of some content-specific humour. In addition to this and throughout the duration of the lesson, the students were constantly reminded of the relevance of the indigenous knowledge/cultural practices documented and presented by the groups for meaningful understanding of the concepts, and the teacher ensured to clear any misconceptions associated with the cultural beliefs. These constituted **steps 3 and 4.**

At the close of the lesson, the students were informed to expect a maximum of 320-character summary of the concluded lesson (two-page message) on their phones which was sent to them by the teacher via SMS and the class WhatsApp platform. However, for the subsequent lessons, the responsibility of sending the summary was given to each group leader. Before the teacher left the class after each lesson, he ensured to inform the students of the next sub-topic and then asked them to repeat step 1 activities. This was **step five.**

This five-step procedure (figure 1) was used throughout the lessons in the experimental group. On the other hand, the control group had no specific treatment. The class activities in the control group were essentially characterised with “chalk and talk”, where the teacher wrote on the board, did all the talking, and the students were just listening for most part of the lessons. In the course of each lesson, the teacher gave assignments on the board and directed the students to check their textbooks for such assignments. At the end of the treatment phase, we conducted the post-test using the PDCAT and four weeks after the post-test we conducted the retention test/post-test using the same instrument. The retention test/post-test was done to check if, relatively, meaningful learning had taken place.

Data Analysis

The data collected for this study were analysed using SPSS IBM version 23. We employed analysis of covariance (ANCOVA) as the statistical tool. We considered this tool appropriate based on the number of the dependent variables measured in the study and because the participants were not randomly assigned into groups. We began the analysis by testing for the parametric assumptions. The data passed the Shapiro-Wilk’s test of normality which shows that the participants for this study were drawn from a normal population; experimental group ($N = 105$) $=.98$; $p > .05$ and the control group ($N = 112$) $= .98$; $p > .05$. The Levene’s test also passed, confirming that the groups (experimental and control) were not significantly different; ($F = .05$; $p > .05$).

Result

Research question 1**:** Will there be a significant difference in the achievement (retention) of senior secondary students taught PDC using CTCA and those taught with lecture method?

Having met the assumptions (Shapiro-Wilk's test of normality and the Levene's test of homogeneity), we applied one-way ANCOVA statistics on the retention test scores of the participants, entering the scores as the dependent factor, the teaching methods as the independent lists, and we input the pretest scores into the covariate box. The result in table 1 shows the mean scores of the two groups after adjustment has been made to the covariate. This indicates that the students taught using CTCA with a mean score of 20.31 outperformed their counterparts taught with the traditional lecture method with a mean score of 15.51, showing a significant mean difference of 4.8. Beyond comparing the mean scores of the groups, the inferential statistics as shown in table 2, revealed that there is a statistically significant difference in the achievement (retention) of students in the experimental and control groups [F(1,214)=103.96; p<.05]. The partial eta squared which explains the effect size of the independent variable on the outcome variable, shows that about 33% of the success recorded by the experimental group is attributed to the teaching strategy they were taught with.

Table 1: Adjusted mean of the retention test scores of the two groups

Descriptive Statistics				
Dependent Variable: Retention test				
			95% Confidence Interval	
Group	Mean	Std. Error	Lower Bound	Upper Bound
Experimental Group	20.305[a]	.330	19.655	20.955
Control Group	15.535[a]	.319	14.907	16.164
a. Covariates appearing in the model are evaluated at the following values: Pretest = 9.8525.				

Table 2: ANCOVA summary table of difference in the achievement of the two groups

Tests of Between-Subjects Effects						
Dependent Variable: Retention test						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1321.426[a]	2	660.713	60.289	.000	.360
Intercept	2620.384	1	2620.384	239.106	.000	.528
Pretest	496.387	1	496.387	45.295	.000	.175
Group	**1139.255**	**1**	**1139.255**	**103.955**	**.000**	**.327**
Error	2345.247	214	10.959			
Total	72756.000	217				
Corrected Total	3666.673	216				
a. R Squared = .360 (Adjusted R Squared = .354)						

Research question 2: What impact will CTCA have on the academic achievement of male and female students in PDC?

The result in Table 3 shows that the male and female students in the experimental (CTCA) group have mean scores with comparable values (male = 19.54 and female = 20.22). As this result could be attributed to error variance, we determine the real result by applying ANCOVA statistics to the data at 95% level of confidence. The result in table 4 therefore shows that there is no statistically significant difference [$F(1,102)=1.76$; $p>.05$] in the achievement of male and female students taught PDC using the culturo-techno-contextual approach (CTCA). The result further indicated that before the intervention, there was a significant difference in the achievement of male and female students in the experimental group (see pretest in table 4). However, after the treatment, both the male and female students performed comparably in their posttest and retention test.

Table 3: Adjusted mean of the retention test scores of male and female students in the experimental group

Descriptive statistics				
Dependent Variable: Retention test				
			95% Confidence Interval	
Gender	Mean	Std. Error	Lower Bound	Upper Bound
Male	19.542[a]	.348	18.851	20.232
Female	20.218[a]	.372	19.479	20.956
a. Covariates appearing in the model are evaluated at the following values: Pretest = 9.0190.				

Table 4: ANCOVA summary table of difference in the achievement of male and female students in the experimental group

Tests of Between-Subjects Effects						
Dependent Variable: Retention test						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	289.026[a]	2	144.513	21.306	.000	.295
Intercept	1677.821	1	1677.821	247.369	.000	.708
Pretest	270.506	1	270.506	39.882	.000	.281
Gender	**11.914**	**1**	**11.914**	**1.757**	**.188**	**.017**
Error	691.831	102	6.783			
Total	42383.000	105				
Corrected Total	980.857	104				
a. R Squared = .295 (Adjusted R Squared = .281)						

Discussion of results

The first research question posed to guide this study sought if there was a significant difference in the achievement (retention) of students taught program development cycle using the CTC approach and those taught using the conventional lecture method, and we found a significant difference in the achievement (retention) of the groups in favour of the experimental group. Therefore, we reject the null hypothesis stated otherwise. This result agrees with the findings of Saanu (2015), Adebayo et al., (2019); Oladejo et al., (2021, 2022) who have established the effectiveness of CTCA as a teaching strategy for tackling underachievement in computer studies and other STEM-related subjects. Contrarily, this result disagrees with the findings of Adolo (2020) who found no statistically significant difference in the achievement of students taught networking using CTCA and those taught with the lecture method.

The studies with the supporting results found that the use of the CTC approach in teaching secondary school students the difficult concepts in STEM subjects meaningfully aids their understanding and in turn bolsters their performance in those subjects, as compared to students taught using the traditional teaching methods. CTCA is a structure made up of culture, technology, context, and sprinkles of other active learning ingredients such as collaboration, group discussion, peer tutoring, classroom interaction among others. Hence, we infer that the potency of this approach speaks through these active ingredients that make it. Prominent among these active agents is the students' culture. Unlike the lecture method where students are passive learners, CTCA allowed for active students' participation in the learning process.

The cultural aspect of CTCA, where the students were given a topic and were asked to seek from their parents or any knowledgeable other the cultural practices or indigenous knowledge related to the topic is recognised as good teaching as it brings education into culture. This form of social interaction helps the students to learn and retain information gained as they were able to find significant connection between school learning and their day-to-day activities. This understanding is deeply rooted in Nkrumah's ethnophilosophy and Vygostky,'s theory of social constructivism. Students in the CTCA groups came to class with some prior knowledge of the topic which they acquire through interaction with their parents or any more knowledgeable other. For such students, learning a new topic was like connecting the dots of ideas to build a wholesome and concrete understanding of the topic. They tend to easily grab the concept of the topic unlike students who came to class with no prior information about the topic to be learned. This learning medium affords the students the ability to gradually move from learning with help to their zone of proximal development (ZPD) - learning without help.

The corroboration of the Ausubel's theory of advance organizer and subsumption theory to this finding cannot be overlooked. In Ausubel's view, to learn meaningfully, students must relate new knowledge of concepts and proposition to what they already know. The students in the CTCA group learned meaningfully as they were able to relate their new knowledge of any given topic in the class to what they already found out from their parents. In step 1 of the implementation of CTCA, the students were also asked to watch videos relating to the topic or concept to be treated in the main lesson, to have a prior knowledge about the topic before coming to class. The knowledge acquired through this pre-lesson activity served as the advance organizer which helped the students to learn meaningfully rather than by rote learning, which is the type of learning that the control group were exposed to. Looking at it from another angle, kinesthetically, students who carried out this task on their own had higher chances of remembering what they were taught during tests than students who were only exposed to read and write teaching methods, after all, students rarely forget what they see (Oladejo and Ebisin, 2021). Hence, the cultural and technology elements of the CTCA appear to be significant ingredients for boosting the students' performance.

Another flavour of CTCA which could possibly contribute to the better performance of the CTCA group than the control group is the contextual examples used to exemplify the concepts being taught during lessons in the CTCA class. Examples play important role in teaching and learning of science concepts. It is a tool used by teachers to drive their point to a clarity level. Examples help to clarify concepts which may seem abstract for students to learn (Pobiner, 2019). Fakoyede and Otulaja, (2019) expressed that the use of physical objects for illustartion in class afford learners a context that enable them to express and expand their cognitive constructs of learning science. However, drawing practical examples that are within the immediate surroundings of the students makes learning real and helps the students to concretise their understanding of the topic being taught.

Contextually revelant examples support learning and healthy development or mental construct of ideas (Okebukola, 2020).

The second research question in this study focused on whether or not there is a significant difference between male and female students' achievement (retention) when taught PDC using the CTCA. The findings revealed that no significant difference exist between the sexes in the CTCA group, therefore, we do not reject the null hypothesis stated alike. This result is in accord with the findings of Oladejo et al., (2022); Agbanimu, et al. (2021); Onowugbeda et al. (2022) who found no gender difference in students' performance when taught using CTCA. This result implies that CTCA is gender insensitive and thus, tend to close the pervasive gender gap in students' performance. Given that these previous studies and current endeavour have differentials in terms of the sample size, school location, subject taught and time of study, yet obtaining similar result, implies that the findings do not occur by chance. It appears there are some unique elements in CTCA that enhance equity in learning between male and female students.

For emphasis, CTCA operates on a five-step implementation process, and we hypothesized that the active agents which contribute to the observed gender equity in learning and performance can be found within these processes. In step 1, all students were saddled with the same tasks; finding indigenous knowledge related to topics and visiting the YouTube for related videos. These assignments have no gender peculiarity; they were the same to females as to male students in the class. One of the sample characteristics in this study is the cultural background which happens to be almost the same for all students (about 74% of the sample comes from the same cultural background), hence, the cultural information gathered by both male and female students share some significant similarities and because the process of collecting/collating the related cultural practices involved a form of storytelling, the female students were not disadvantaged.

On area of technology use (pre-lesson YouTube information), there are no gender characteristics in the videos available to the male and female students. The quality and quantity of YouTube contents available for male are also accessible by the female students. YouTube has been ranked as one of the most visited social media platforms in Nigeria, and more so, studies have showcased the effectiveness of this platform on improving learning outcome and bridging the gender gap in learning (Alabi, Falode, Adebambo, & Abdulkareem, 2020; Koledoye, 2021; Ogirima, Tolulope, & Temitope 2021; Olalere, & olatokun, 2020; Ono, Chiaghana, & Okeke, 2021). This suggests that the use of YouTube videos as a primer for meaningful learning in CTCA is not only proving to be an effective strategy, but also as non-gender stereotyped. This is not so surprising as one may have noticed that women participation in some male dominated activities have increased as technology penetrates every facet of human endeavour (Oladejo, Nwaboku, Okebukola and Ademola, 2021).

The equal performance of male and female students in the CTCA group could also be attributed to the classroom interaction which is a crucial tenet of the CTC approach featured in step 2. It has been established empirically that classroom interaction among the students enhances their understanding and in turn improves their performance (Sanni and Fakunle, 2016). The CTCA affords the students (male and female) the opportunity to share and as well gain knowledge from their peers through group discussion while they were grouped in mixed sex and ability. Peers' collaboration is a characteristic which is largely common among female students, the group discussion therefore gives the female students a soft landing as they were able to learn meaningfully among their peers. As noted by Nzewi (2020), the traditional science classrooms/lessons are always competitive, whereas female students thrive better in a cooperative learning environment.

Conclusions

The study investigated the impacts of CTCA on senior secondary students' achievement (retention) in program development cycle- a perceived difficult concept in computer studies. The results obtained indicated that CTCA significantly improves students' achievement (retention) in PDC. It further adds to the few literatures on gender equity in academic performance. The results of this study were found to be consistent with the findings of previous studies on CTCA, establishing the potency of the approach in promoting meaningful learning. With the growing concern for inclusion, diversity and equity in STEM learning, it is becoming increasingly noticeable that the conventional teaching method can no longer meet the need of students. CTCA is presented as a potential suitable substitute for STEM traditional teaching and learning. While we do not make claims to generalize the findings of this study given its limitations, we recommend the CTCA to ICT teachers in Nigeria and other culturally immersed societies as viable pedagogical tool for promoting meaningful learning. We further invite fellow researchers to explore the potency of the CTC approach on other perceived difficult concepts in ICT and other STEM subjects. A future direction for this study would be a replication which addresses the current limitations with respect to a number of difficult concepts/topics, duration of treatment and sample size. Overall, we submit that the key to Nigeria and Africa’s technological development lies in our jettisoned cultural practices and indigenous knowledge as it were for other regions ahead of Africa.

References

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. https://www.youtube.com/watch?v=Ox0z_nxOQzc&t=845s

Adolo, V. (2020). Potency of Culturo-Techno-Contextual Approach (CTCA) in Improving Achievement of Secondary School Students in Networking. In Peter A. Okebukola (Ed.). *Breaking barriers to learning: The Culturo-Techno-Contextual Approach (CTCA)*. Slough, UK and Delhi: Sterling Publishers.

Agbanimu, D. O. (2020). Algorithm and Flowchart as Difficult Concepts for Secondary School Students in Information Communication Technology: Harnessing the Power of Indigenous (Cultural) Knowledge for their Understanding. In P. A. Okebukola (Ed), *Breaking Barriers to Learning: The Culturo Techno-Contextual Approach (CTCA*) (pp. 253-266). Sterling Publishers.

Agbanimu, D. O., Okebukola P. A., Oladejo, A. I., Onowugbeda, F. U., Peter, E.O., Awaah, F., Ademola, I. A., Gbeleyi, O. A., & Allename, F. A. (2022, March 27-30). 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.

Alabi, T. O., Falode, O. C., Adebambo, M. R., & Abdulkareem, A. Y. (2020). The Utilization of YouTube Videos for Instructional Purposes. *IJER-International Journal of Educational Research*, *3*(09), 01-12. http://gphjournal.org/index.php/er/article/view/309

Amusa, J. O., Ayanwale, M. A., Oladejo A. I., Ayedun, F. (2022). Undergraduate Physics Test Dimensionality and Conditional Independence: Perspective from Latent Traits Model Package of R Language. *The International Journal of Assessment and Evaluation*. *29*(2), 47-61. https://doi:10.18848/2327-7920/CGP/v29i02/47-61.

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

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

Bogopa, D. L. (2012). The importance of indigenous games: the selected cases of indigenous games in South Africa. *Indilinga African Journal of Indigenous Knowledge Systems*, *11*(2), 245-256. https://hdl.handle.net/10520/EJC132012

Bovée, C., Voogt, J., & Meelissen, M. (2007). Computer attitudes of primary and secondary students in South Africa. *Computers in Human Behavior, 23*(4), 1762-1776. https://www.sciencedirect.com/science/article/pii/S0747563205000865.

Britz, J. J., & Boekhorst, A. K. (2004). Information literacy at school level: A comparative study between the Netherlands and South Africa. *South African Journal of libraries and information science*, *70*(2), 63-71.

Bustos-Works, C., Whiles Lillig, J., Clark, C., Daubenmire, P., Claesgens, J., Shusterman, A., ... & Nguyen, H. D. (2021). Moving Toward Inclusivity in Chemistry by Developing Data-Based Instructional Tasks Aimed at Increasing Students' Self-Perception as Capable Learners Who Belong in STEM. *Journal of Chemical Education*, *99*(1), 177-184. https://doi.org/10.1021/acs.jchemed.1c00366

Chukwuemeka, E. J., Nsofor, C. C., Falode, O. C., & Aniah, A. (2019). Assessing pre-service teachers' technological pedagogical content knowledge self-efficacy towards technology integration in Colleges of Education in South-west Nigeria. *Journal of Science, Technology, Mathematics and Education, 15*(3), 143-151. http://repository.futminna.edu.ng:8080/jspui/handle/123456789/2988

du Plessis, A., & Webb, P. (2012). Teachers' Perceptions about their Own and their Schools' Readiness for Computer Implementation: A South African Case Study. *Turkish Online Journal of Educational Technology-TOJET, 11*(3), 312- 325. https://eric.ed.gov/?id=EJ989223.

Fakoyede, S. J., & Otulaja, F. S. (2020). Beads and beadwork as cultural artifacts used in mediating learners' agentic constructs in science classrooms: A case for place-based learning. *Cultural Studies of Science Education*, *15*(1), 193-210. https://doi.org/10.1007/s11422-019-09911-4

Gbeleyi, O., Okebukola, P. A., Oladejo, A. I., Ademola, I., Onowugbeda, F. U., Awaah, F., Peter, E., Agbanimu, D., Ganiyyu, A. B., Abdulazeez H. T. (2022, March 27-30). Heartbreak for Underachievement: Perspectives of CTCA on Students' Achievement and Critical Thinking in Computer Studies [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.

Hart, S. A., & Laher, S. (2015). Perceived usefulness and culture as predictors of teachers attitudes towards educational technology in South Africa. South African Journal of Education, 35(4). https://www.ajol.info/index.php/saje/article/view/127075.

Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale online journal of African studies*, *2*(1), 39-54.

Jophus, A. (2020, April 27). *Indigenous Knowledge System and Quality STEM Education* [PowerPoint slides]. LASU ACEITSE Lecture on Indigenous Knowledge System and Quality STEM Education - YouTube

Kola-Olusanya, A. (2020). The Confluence of Indigenous Knowledge (Culture), Technology and Context in Promoting Environmental Education in Africa. In Peter Okebukola (Ed.). *Breaking barriers to learning: The culture-techno-contextual approach (CTCA).* Slough, UK and Delhi, India: Sterling Publishers.

Koledoye, U. L. (2021). Information and Communication Technology Utilization for Skill Acquisition among Adult Distance Learners in Enugu State, Nigeria. *Journal of Home Economics Research*, 210

Koorsse, M., Cilliers, C., & Calitz, A. (2015). Programming assistance tools to support the learning of IT programming in South African secondary schools. *Computers & Education, 82*, 162-178. https://www.sciencedirect.com/science/article/pii/S0360131514002735.

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into practice*, *34*(3), 159-165.

Moloi, T. (2013). The teaching of mathematics in rural learning ecology using Morabaraba game (board game) as an example of indigenous games. *International Proceedings of Economics Development and Research*, *60*, 124.

Moses, A. (1992). Culture, contexts and learning. New York: Marshall Press.

Mtebe, J. S., & Raphael, C. (2018). Eliciting in-service teachers' technological pedagogical content knowledge for 21st-century skills in Tanzania. *Journal of learning for development*, *5*(3), 263-279. https://jl4d.org/index.php/ejl4d/article/download/288/338?inline=1

Naidoo, J. (2021). Integrating Indigenous Knowledge and Culturally based Activities in South African Mathematics Classrooms. *African Journal of Teacher Education*, *10*(2), 17-36. https://doi.org/10.21083/ajote.v10i2.6686

Ogirima, O. A., Tolulope, J. J., & Temitope, S. J. (2021, April). Future Teachers' Perception towards the Use of YouTube for Teaching-Learning Activities in Nigerian Basic Schools. In *Elementary School Forum (Mimbar Sekolah Dasar)* (Vol. 8, No. 1, pp. 81-95). Indonesia University of Education. Jl. Mayor Abdurachman No. 211, Sumedang, Jawa Barat, 45322, Indonesia. Web site: https://ejournal. upi. edu/index. php/mimbar/index. https://eric.ed.gov/?id=EJ1300146

Okebukola, P. A., Gbeleyi, O.A., Agbanimu, D. O., Peter, E., Ebisin, A. F., Oladejo, A. I., … & Ajayi, O. A. (2020). *Aetiology of Topic Difficulty in the New Computer Studies Curriculum in African Schools: Taming the Tiger* [Unpublished article].

Okebukola, P. A., Ige, K., Oyeyemi, A., Olusesi, O., Owolabi, O., Okebukola, F., & Osun G. (2016,). *Exploring the impact of culturo-tecno-contextual-approach (CTCA) in tackling underachievement in difficult concepts in Biology* [Conference paper]. 2016 NARST conference, Baltimore, USA.

Okebukola, P.A. (2020). *Breaking Barriers to Learning: The Culturo Techno-Contextual Approach (CTCA*). Sterling Publishers.

Okebukola, P.A.O. (2012). Sustaining Indigenous Science and Technology Culture in Africa. *Journal of African Culture and International Understanding*, No. 1, 15-18.

Oladejo A. I., Akinola, V. O. & Nwaboku, N. C. (2021). Teaching Chemistry with Computer Simulation: Would Senior School Students Perform Better? *Crawford Journal of Multidisciplinary Research, 2*(2), 16-32.

Oladejo, A. I. (2018). Computer Simulation and Cognitive Achievement in Senior Secondary School Chemistry [Master's thesis]. *Lagos State University*.

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.

Oladejo, A. I., Ademola, I., Okebukola, P. A. O., Awaah, F., Agbanimu, D., Onowugbeda, F., ... & Odekeye, T. (2021, Apri 27-30l). *In Search of New Tools for Meaningful Learning in Chemistry–We Stumbled on Culturo-Techno-Contextual Approach*. Presented at NARST 94th Annual International Conference—Science Education, A Public Good for The Good of The Public? Research to Empower, Evoke, and Revolutionize, Virtual Conference.

Oladejo, A. I., Nwaboku, N. C., Okebukola, P. A., & Ademola, I. A. (2021). Gender difference in students' performance in chemistry–can computer simulation bridge the gap? *Research in Science & Technological Education*, 1-20. https://doi.org/10.1080/02635143.2021.1981280

Oladejo, A. I., Okebukola, P. A., Adebayo, I., Adeosun, G., Agbanimu, D., Ademola, I., ... & Awaah, F. (2022, March 27-30). *I am CTCA, and this is my first Attempt in the Physics Class-How Will I perform*? [Conference Proposal]. Presented at NARST 95th Annual International Conference—Unity and Inclusion for Global Scientific Literacy: Invite as a Community. Unite as a Community, Vancouver, British Columbia.

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.

Olalere, J. O., & Olatokun, W. M. (2020). Does Parenting Style Influence Children's Use of Social Media? Observations from a Faith-based Secondary School, Ibadan, Nigeria. *Library Philosophy and Practice*, 1-14.

Olawuwo, A. F. (2016, May 17-20). *The Role of Science and Technology in Curbing Insecurity in Nigeria* [Conference Proceedings]. 4th Faculty of Education International Conference: Education for Global Security, Lagos State University.

Ono, G. N., Chiaghana, C. A., & Okeke, A. O. (2021). Investigating Information Usefulness of YouTube among Select Unizik Students. *Nnamdi Azikiwe University Journal of Communication and Media Studies*, *2*(1).

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

Pobiner, B., Watson, W.A., Beardsley, P.M., Bertka, C.M. (2019). Using Human Examples to Teach Evolution to High School Students: Increasing Understanding and Decreasing Cognitive Biases and Misconceptions. In: Harms, U., Reiss, M. (eds)

Evolution Education Re-considered. Springer, Cham. https://doi.org/10.1007/978-3-030-14698-6_11

Saani, R. I. & Fakunle, O. I. (2016, May 17-20). *An Exploration of Classroom Interaction as a Strategy for Improving Students' Achievement in Mathematics* [Conference proceedings]. LASU 4th International Conference: Education for Global Security, Lagos State University, Nigeria.

Saanu, T. (2015). Exploration of the effect of the culturo-techno-contextual approach on the achievement and attitude of students in logic gate. In Peter Okebukola (Ed.). *Breaking barriers to learning: The culture-techno-contextual approach (CTCA).* Slough, UK and Delhi, India: Sterling Publishers.

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

West African Examination Council (WAEC), (2018). Summary of SSCE Results for computer studies, Yaba, Lagos.

Yadav, A., & Berges, M. (2019). Computer science pedagogical content knowledge: Characterizing teacher performance. *ACM Transactions on Computing Education (TOCE), 19*(3), 1-24. https://doi.org/10.1145/3303770