The culturo-techno-contextual approach and students' understanding of computer science education in a developing economy

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Abstract

Purpose – The lecture method has been compared with teaching methods such as flip learning, cooperative learning and simulations to establish which holds the key to students' understanding of concepts. What is bereft in the education literature is its comparative efficiency with the culturo-techno contextual approach (CTCA) in the teaching of computer science education.

Design/methodology/approach – This study adopted the quasi-experimental design to determine the efficacy of the CTCA in breaking difficulties related to the study of spreadsheets as a difficult concept in the Nigerian computer science education curriculum. Junior high school students studying computer science education participated in the study. The control group had 30 students, with 35 students in the experimental group. The experimental group was taught using CTCA, while the control group used the lecture method. The spread sheet achievement test, which had 40 items on spreadsheet, was used to collect data.

Findings – The results showed that the experimental group significantly outperformed the control group [$F(1,60) = 41.89$; $p < 0.05$]. The findings showed the potential of CTCA in improving students' performance in spreadsheets in the computer science education curriculum.

Originality/value – The originality of this study is hinged on its ground-breaking test of the CTCA to the study of the spreadsheet. The findings of this study indicate its efficacy in improving students' understanding of spreadsheet and computer science education.

Keywords Spreadsheet education, Culturo-techno-contextual approach, Difficult concepts education pedagogies

Paper type Research paper

Introduction

There is a need for science educators to understand the relationship between cultural and socioeconomic issues and the science education of inner-city students (Barton and Yang, 2000). While their study may be relative to inner-city students, it may be applicable

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in developing economies like Africa. Some studies (e.g. Wood *et al.*, 2013; Akerele, 2016; Ngcobo, 2019) have recently explored conceptualisations of culture that address contemporary challenges in science education. This emphasises the importance of culture in science education in recent times. Culture has been commonly used in science education research, particularly to examine equity issues for students from low-income, racial and ethnic minority communities. It has provided a lens to appreciate science classrooms as cultural places and recognise the importance of students' cultural ways of being as resources for science learning (Seiler, 2013). Despite these gains culture is achieving in the science classroom, Africa seems not to have fully tapped into its culture in the teaching and learning of science, although some emerging efforts are evident (Okebukola, 2020).

Current literature in Africa's education points to a cultural teaching model (culturo-techno-contextual approach – CTCA) to overcome difficulties in science education (Awaah *et al.*, 2021, 2022; Onowugbeda *et al.*, 2022; Oladejo *et al.*, 2022; Awaah, 2023). CTCA is a model (method) of teaching and learning designed to break down many traditional barriers to meaningful learning that existing teaching methods failed to address. This approach is an amalgam, drawing on the power of three frameworks – (a) the cultural context in which all learners are immersed, (b) the technology-mediation to which teachers and learners are increasingly dependent and (c) the 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 (Okebukola, 2020).

Despite the great emphasis on the teaching of computer studies because of its central role in technological advancement, students continually find its study difficult. Qian and Lehman (2017) attribute the difficulties experienced by students in the study of computer science to many factors, including unfamiliarity with syntax, natural language, math knowledge, inaccurate mental models, lack of strategies, programming environments and teachers' knowledge and instruction. However, many sources of students' difficulties have connections with students' prior knowledge. Their assertion on natural language and programming environments as inhabitants of students' understanding of computer science rationalises our study on whether the CTCA, especially culture and context (which largely influence natural language and programming environments), will influence students' understanding of spreadsheet in the computer science curriculum in Nigeria.

While the work of Qian and Lehman (2017) justifies our study, Okebukola *et al.* (2020), in a glimpse of transactions in science classrooms in five African countries (Burundi, Ghana, Morocco, Nigeria and Senegal) during the COVID-19 lockdown, report four major challenges to the delivery of science education: a teacher capacity deficit for delivering online education, poor internet service, an erratic power supply and severe inadequacies in infrastructure for open and distance education. With poor teacher motivation induced by low and irregular wages, these challenges are depressants to quality science teaching during the COVID-19 period.

Though these challenges relative to the study of computer science are noted, other areas of study have reported evidence of the potency of the CTCA in resolving difficulties relative to the study of the difficult concept (Awaah *et al.*, 2021). This deficit in the literature on the use of the CTCA in easing student's difficulties in the study of computer science education further justifies our quest to test the efficacy of the CTCA in resolving difficulties in the study of the spreadsheet in the computer science education curriculum in Nigeria in a bid to fill the research gap relative to the use of CTCA in resolving students challenges in studying computer science.

In resolving the problem of difficulties relative to students' understanding of spreadsheets, our study seeks to find out whether there is a statistically significant difference in the academic achievement in spreadsheets between students taught using the CTCA and those taught using the lecture method. Based on this objective, the researchers formulated the null hypothesis that there will be no statistically significant difference

between students taught using the CTCA and students taught using the lecture method in the academic achievement in the spreadsheet.

The uniqueness and new knowledge this study brings into the computer science literature is that it tests a cultural teaching method (i.e. CTCA) to ascertain whether it enhances students' understanding of computer science. Beyond computer science, the methodology departs from the regular lecture method and proffers a cultural teaching method different from existing models of testing students' understanding of concepts. Theoretically, the relevance of the study, especially the application of the CTCA, is that it draws largely from the culture with an effective blend of technology and context to enhance students' achievements. The African region of the theory also adds to emerging homegrown theories targeted at enhancing teaching and learning in the region and elsewhere.

Theoretical framework

Culturo-techno-contextual approach

The culturo-techno-contextual approach is a teaching method deeply rooted in culture, technology and the context of the environment in which teaching and learning occur. The relevant philosophies that this approach relies on are those adopted by Kwame Nkrumah (ethnophilosophy) for culture, Martin Heidegger (technophilosophy) for technology and Michael Williams (contextualism) for the contextual part of CTCA.

Ethnophilosophy is the study of indigenous philosophical systems. The implicit concept is that a specific culture can have a philosophy that does not apply to all people and cultures and simultaneously have similarities with other cultures around the world; however, this concept is disputed by traditional philosophers. An example of ethnophilosophy is African philosophy. The term ethnophilosophy was first used by Kwame Nkrumah and was coined by Paulin J. Houtondji, who views it as a combination of ethnography and philosophy. Ethnophilosophy is based on the works of ethnographers, sociologists and anthropologists who interpret collective world views of African people, their myths and folklores as a constitutive part of African philosophy. The study of ethnophilosophy has enabled Africans to know that they are rational thinkers and are not inferior, as such arguments made by Westerners are false. According to Okebukola (2020), ethnophilosophy is seen as an item of communal property rather than an activity for the individual. CTCA draws from the beliefs and practices of indigenous communities to scaffold the teaching and learning of science, and, indeed, any subject for that matter. It will appear that, of the three components of the CTCA, Okebukola places much emphasis on culture as a factor that enhances students' understanding compared to technology and context.

The philosophy of the "techno" component of CTCA is entrenched in the "Heideggerian" philosophy. Technology, according to Heidegger, must be understood as "a way of revealing the world, a revealing in which humans take power over reality".

The context element of CTCA is dependent on the philosophical framework of contextualism. Contextualism argues that our actions, utterances, expressions and learning can only be understood relative to that context. When using CTCA in teaching students, the topic must be related to their immediate environment to enable the students to assimilate the explanation easily.

Hierarchically, the model places a second emphasis on context (environment) and technology at the tail. The concept argues that apart from the cultural or indigenous knowledge relative to the study of concepts, the environment in which the concept is taught and how teachers can relate the concept taught to the environment is a key factor in enhancing students' understanding, apart from culture. At the model's tail is the technology that complements culture and context to aid students' understanding.

Theoretical and methodological antecedents of the culturo-techno-contextual approach

Since the mid-19th century, the quest for more potent methods of bolstering students' performance has become unstoppable and irresistible. Such methods as cooperative learning, concept maps, demonstration, analogies and metaphors and methods with constructivist flavours have populated literature. Yet, despite the deployment of some of these methods in classrooms, the same literature in the second decade of the 21st century is replete with reports of the lacklustre performance of students in many countries (Canning *et al.*, 2018; d'Aguiar and Harrison, 2016; Ejiwale, 2013; Hoeg and Bencze, 2017; Smith *et al.*, 2014; Watkins and Mazur, 2013). Okebukola (2020) observes that the one-size-fits-all models have failed woefully and argues for culturally immersed and contextually situated teaching methods. This is the underpinning principle of the CTCA experimented within this study.

Theoretically, the CTCA development is based on Western theories, namely, Jean Piaget's cognitive constructivist theory, Vygotsky's cultural-historical theory and David Ausubel's theory of advanced organisers. Jean Piaget, a psychologist, propounded cognitive constructivism. The theory deals with the nature of knowledge itself and how humans gradually come to acquire, construct and use it. To Piaget, cognitive development is a pragmatic reorganisation of mental processes resulting from biological maturation and environmental experience. He believes that students construct an understanding of the world around them, experience discrepancies between what they already know and what they discover in their environment and then adjust their lives and existing knowledge accordingly. Moreover, Piaget claimed that cognitive development is at the centre of the human organism, and language is contingent on knowledge and understanding acquired through cognitive development. Vygotsky's cultural-historical theory observed the Marxist notion of tool invention's impact on human mental life (thesis) and the anthropological perspective of culture's function in human evolution via dialectical synthesis (antithesis). His answer was to classify cultural signals and symbols as psychological tools, which he characterised as cognitive growth instruments (Gredler, 2014). According to Gredler, their significance stems from the fact that early humans produced signals (basic psychological tools) that indicated the species' development towards sophisticated thinking (phylogeny). The aim of the person in society is to adapt one's culture's symbol systems to create similar kinds of thinking (ontogeny). This orientation by Vygotsky, as reflected in the works of Gredler (2014), finds linkage in the cultural component of the CTCA as espoused by Okebukola (2020).

This implies that signs and symbols such as human speech, written language and algebraic and mathematical symbols used in computer science education have culturally served as transmitters of both meaning and social cohesion in human lives. Vygotsky highlighted a second critical role: helping people in mastering complicated cognitive skills that are not completely formed until puberty (Gredler, 2014). These skills, according to Gredler, are voluntary (self-regulated) attention, categorical perception, conceptual reasoning and logical memory, which Vygotsky refers to as complex or higher cognitive processes. This component of Vygotsky's theory relates to the first step of Okebukolas' CTCA, where cultural knowledge is expected to be harnessed from the elderly, self, relatives, friends and the immediate environment. Gredler argues that Vygotsky equated better cognitive functioning, cultural development of conduct and mastery of one's behaviour through internal processes, which is particularly significant. Higher cognitive processes, which need self-mastery, emerge from biological activities through a complicated dialectical process. The process necessitates the child's mastery of external cultural reasoning resources, which become internal thinking mechanisms, reflective of the context component of the CTCA.

Vygotsky's theory foreshadowed later talks about the need to produce self-regulated learners who can guide and govern their learning and thinking. In contrast to these viewpoints, Vygotsky established two general criteria for developing self-directed thinking, which has had little effectiveness in teaching specific self-regulatory techniques for specific situations. Firstly, pupils gain conscious awareness and control over their mental processes before higher cognitive capabilities arise. Secondly, school education should emphasise the development of these broad talents, leading to self-control development. Vygotsky's description of the four phases of learning to utilise symbols for thinking illustrates the lengthy process necessary to acquire self-mastery and higher cognitive processes. Symbol usage goes from pre-intellectual (infant cannot master their behaviour by arranging chosen inputs) to internalisation (individuals create self-generated symbols as memory aids) in developing logical memory.

The social connection between the learner and a competent adult is critical to cognitive growth. Higher cognitive function development is influenced by scenarios in which an adult directs the learner's attention, concentrates their perception or leads the learner's conceptual thinking. According to the formal definition, any higher cognitive function, such as self-regulated attention, categorical perception or conceptual thinking, was initially externalised in the form of a social connection between two persons. It is then internalised as a metacognitive function resulting from the learner's action. The final Western theory the CTCA is hinged on is Ausubel's theory of advance organisers. Ausubel promotes advanced organisers to connect new learning material with existing notions. Advanced organisers are brief introductions to a topic that provides the structure for the student to link the new material provided with his prior knowledge.

Empirical studies with the culturo-techno-contextual approach as the teaching method

Many researchers have investigated the impact of several teaching methods on enhancing students' academic achievements. One new method/approach of teaching is the CTCA propounded by Okebukola (2020). Advocates of this teaching method have argued that an effective blend of one's culture with technology and the context of the concepts under study will help students easily understand concepts in any area.

Adam (2019) sought to investigate the potency of the culturo-techno-contextual approach on students' achievement and attitude towards mutation and variation. Using 60 senior secondary three biology students, the study reported a positive impact of the CTCA on students' achievement in mutation and variation as the experimental group students performed better than the control group students on the achievement measure.

In a study titled "Experimental Assessment of the Potency of Culturo-Techno-Contextual Approach in Enhancing Performance in Difficult Concepts in the Ghanaian Undergraduate Public Administration Curriculum" Awaah (2020) sought to examine the efficacy of the CTCA in aiding students' understanding of two of the perceived difficult concepts: politics and bureaucracy in public administration. A total of 133 second-year diploma students studying public administration participated in the experimental phase of the study. The control group had 44 students, with 89 students comprising the experimental group. The Politics and Bureaucracy Achievement Test (PABAT), which had 15 items on politics and 15 items on bureaucracy, was used to collect data. Since random assignment to experimental and control groups could not be achieved, the analysis of the covariance procedure was applied to the data, with pre-test scores inserted as the covariate. The results showed that the experimental group (mean = 22.20 and SD = 5.10) significantly outperformed the control (mean = 20.45 and SD = 8.01) in politics and

bureaucracy [F (1, 130) = 14.07; p = 000]. The findings show the potential of CTCA in improving undergraduate students' performance in selected difficult concepts in public administration.

Criticism of the culturo-techno-contextual approach

Despite the usefulness of CTCA, Awaah (2020) posits that the CTCA may be saddled with challenges such as lack of support and cooperation from the management, teachers and other staff of the school where CTCA is to be carried out, lack of internet-enabled devices by students, small or insufficient-time frame for the lesson, lack of motivation on the part of learners to take up the responsibility of doing the assignment given and teacher's knowledge and competence in solving misconceptions that might arise when cultural belief is inconsistent with the scientific explanation at hand.

Material and methods

Population and sampling

The population for the study consists of all final-year junior secondary school students of the Badagry local government area. The sample used for the study comprised two schools; one for the control group comprised 35 JSS 3 students from the Nigeria French Language Village. Thirty JSS 3 students from the Royal Spry College comprised the experimental group. The name "French Village" represents the schools' efforts to teach the use of French in professional settings. However, not all teaching and learning is conducted in French. Apart from the French subject itself, all others are taught using English. Thus, both classes were taught using English.

The quasi-experimental-control group research design involves selecting groups upon which the variable is tested without any random pre-selection process. Therefore, a purposive sampling technique was adopted to select 30 students for the experimental group. The sample was of mixed ability and mixed-sex groups.

Research design

The researcher adopted the quasi-experimental-control group design involving pre-test and post-test. Before the treatment, the pre-test was administered to both groups to determine the students' base ability. The experimental group was taught spreadsheets using the CTCA. The control group was taught the same topic using the lecture method. A post-test was administered to both groups at the end of the treatment.

Furthermore, a quasi-experimental design was employed. A quasi-experiment does not rely on random assignment, but subjects are assigned to groups based on non-random criteria. In our study, existing schools and classrooms were adopted without altering the existing numbers in the classrooms. This required the adoption of the quasi-experimental design. A quasi-experimental design that uses a control group is preferable to a design that does not use a control group (Eliopoulos *et al.*, 2005). As the name suggests, "quasi-experiments" aspire to approximate the "experimental methods", usually in settings where "full experimental control" is not possible because researchers are trying to identify the consequences of social change. As a naturalistic contest the drive to generalise research results to natural stick settings precludes the use of one traditional experimentation that we call the tradition experimental control and isolation (Cook and Campbell, 1986). The quasi-experimental design can be justified for at least two reasons: (a) randomised experiments are not always possible because of ethical or practical constraints; thus, researchers may have no choice in many situations except to fall back on quasi-experimental designs; (b) science often

progresses best when it employs a diversity of methods that have a corresponding diversity of strength and weaknesses (Mark and Reichardt, 2004).

The pre-test-post-test non-equivalent groups' adopted design is shown diagrammatically in Figure 1.

Research instrument

A SAT and an interview guide were used to collect data for this study. The SAT was a self-designed design instrument by the researchers consisting of 40 items. The instrument was intended to examine students' abilities on spreadsheets. The questions were developed from the lesson note prepared for teaching students, while some questions were derived from the past Basic Education Certificate Examination (BECE).

To ensure that the SAT is consistent and accurate, it was subjected to split-half reliability testing and analysed using SPSS; an acceptable reliability coefficient value of 0.77 was obtained. For validity, the instrument was reviewed by 12 experts in computer science education from Nigeria. Upon endorsement of validity, the test was administered to students. It contained 30 multiple choice questions from the topic spreadsheet. The type of questions that were answered comprised options A–D, with students required to choose the answer that best describes the question. The responses informed the researcher on the efficacy of the CTCA compared to the lecture.

CTCA and spreadsheet perspectives

The spreadsheet is a topic that has been perceived to be difficult in secondary schools. Students were taken through the following lessons under the spreadsheet:

(1) Definition of spreadsheet package.

(2) Examples of spreadsheet packages.

(3) Functions of parts of spreadsheets.

(4) Uses of spreadsheet packages.

Procedure for data collection

After seeking permission from school authorities to experiment, the researcher ensured a friendly atmosphere wherein the respondents felt relaxed and ready to participate. The following procedure was adopted for the treatment using the CTCA for the experimental group.

O_1 X O_2 E (The Royal Spry College)

O_3 -- O_4 C (Nigeria French Language Village)

Where O_1O_3 = Pretest, O_2O_4 = Post-test

E = experimental group

X = treatment; Culturo-techno contextual approach

Source(s): By authors

Figure 1.
Pre-test-post-test non-equivalent groups

Step 1: The teacher gave a pre-lesson assignment to the students to seek information from their family and friends on indigenous knowledge and cultural practices on spreadsheet and use their mobile phones and other Internet-enabled devices to search the web for resources and watch YouTube videos on the topic "Spreadsheet".

Step 2: The teacher welcomed the students to the class and divided the students into groups of 10 consisting of both sexes with mixed academic intelligence.

Step 3: Each group was given 8 min to discuss and share their various opinions and insights on the allotted topic.

Step 4: The teacher selected a group leader from each group to give a detailed summary of their discussion on the topic.

Step 5: The teacher then proceeded with the topic "Spreadsheet" by relating the topic to cultural attributes (cultural approach), pointing out several examples and instances spreadsheets can be related to daily contributions and hospital cards.

Step 6: The teacher advanced the instructional process by applying a contextual approach while teaching the topic to the students to help them familiarise themselves with the use of spreadsheets in everyday life.

Step 7: After the class, the teacher sent what was learnt (content) to the students through WhatsApp.

The procedure was modified from the original steps involved in teaching, using CTCA as stated by Okebukola (2020). The procedure for teaching using CTCA is shown diagrammatically in Figure 2.

In using the teaching method for the control group, the researcher employed the following procedure.

Step 1: The teacher introduced the topic spreadsheet and its various definitions to the students.

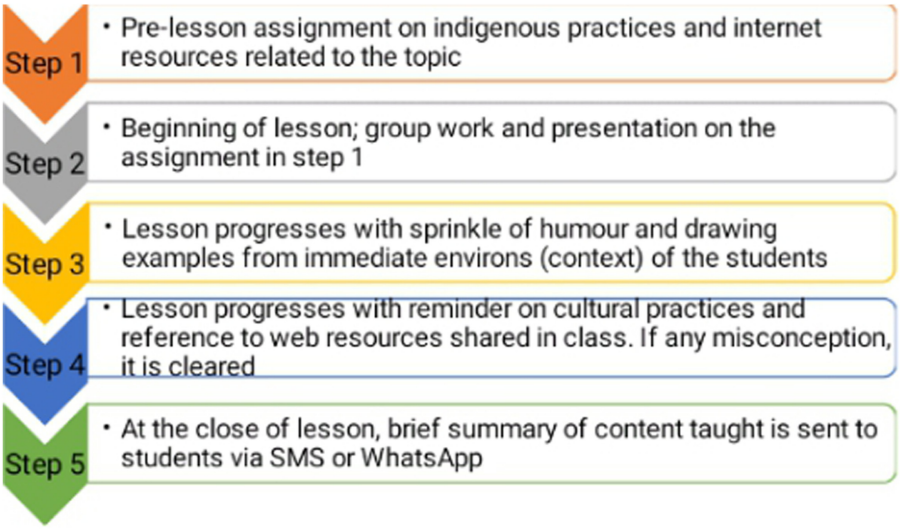

Figure 2.
Procedure in teaching using the CTCA

Source(s): Courtesy of Okebukola (2020)

Step 2: The teacher then guided the students to list the examples of spreadsheet packages.

Step 3: The teacher asked the students to explain the functions of the parts of spreadsheet applications, and the students responded.

Step 4: The teacher corrected the students where necessary.

Step 5: The teacher finally guided the students to mention the uses of spreadsheet packages.

Data analysis technique

The data generated from the SAT were analysed in IBM-SPSS version 23 using the analysis of covariance (ANCOVA) to test for a statistically significant difference between the CTCA and lecture method in learning of spreadsheet at alpha level $p < 0.05$. Qualitative data from students were analysed using content analysis.

Results

Table 1 shows the breakdown of school, gender and teaching approaches for the control and experimental groups. Out of the 65 participants, 23 males and 42 are females. Only two teaching approaches were used: CTCA and lecture method.

To test the null hypothesis (i.e. there is no statistically significant difference between students taught using the CTCA and students taught using the lecture method in the academic achievement spreadsheet), ANCOVA was run. The Levene's test of equality of error variances shows statistically non-significant results, allowing ANCOVA to be used for the analysis (Table 2). From the analysis, the ANCOVA result shows a statistically significant difference in the academic achievement of students taught spreadsheet using CTCA and lecture method [$F(1,60) = 41.89; p < 0.05$] (Table 3). Therefore, the null hypothesis is rejected.

Given the means and standard deviations, Table 4 shows that students taught using the CTCA performed better than those taught using the lecture method.

When qualitatively interrogated on why teaching spreadsheet with CTCA enhanced students' understanding of the concepts, randomly sampled and unnamed students had this to say:

Onyeka (pseudonym)

I got answers from different sources online, which helped me understand the topic deeper.

School	Teaching approach	Male	Female	Total
Royal Spry College	CTCA	12	18	30
Nigeria French Language Village	Lecture	11	24	35
Total		23	42	65

Source(s): By authors

Table 1. Breakdown of school, gender and teaching approaches for control and experimental groups

F	df1	df2	Significant value
0.82	3	61	0.49

Source(s): By authors

Table 2. Levene's test of equality of error

Adeyemo (pseudonym)
The pre-class assignments enabled me to get a base understanding of the topic before coming to class.

Aishat (pseudonym)
The use of cultural examples made it easier for me to relate to the topic.

Abubakar (pseudonym)
The assignments given before class boosted my confidence, so I was able to answer questions in class which also increased my understanding.

Mary (pseudonym)
I liked the use of the local examples. It made the topic look like something I had always known.

Discussion

We sought to identify whether there is a statistically significant difference in the academic achievement of students taught spreadsheet using CTCA and lecture method. Our findings showed that students taught with the CTCA performed better in the spreadsheet achievement test than students taught using the traditional lecture method.

Our findings support for the underpinning theories. For instance, to Piaget, cognitive development is a pragmatic reorganisation of mental processes resulting from biological maturation and environmental experience, reflecting the contextual component of the CTCA. Also, Vygotsky's cultural-historical theory observed the anthropological perspective of culture's function in human evolution via dialectical synthesis. The aim of the person in society is to adapt one's culture's symbol systems to create similar kinds of thinking. This orientation by Vygotsky, as reflected in the works of Gredler (2014), finds linkage in the

Table 3.
Summary table of ANCOVA

Source	Type III sum of squares	Df	Mean square	F	Sig	Partial eta squared
Corrected model	795.591[a]	4	198.90	23.46	0.00	0.610
Intercept	743.80	1	743.80	87.74	0.00	0.594
Achievement pre-test	240.95	1	240.95	28.42	0.00	0.321
Method	355.13	1	355.13	41.89	0.00	0.411
Gender	4.81	1	4.81	0.57	0.45	0.009
Method*gender	0.83	1	0.82	0.10	0.76	0.002
Error	508.66	60	8.48			
Total	50,488.00	65				
Corrected total	1,304.25	64				

Source(s): By authors

Table 4.
Mean gain scores for experimental and control group

Method	Mean	Standard deviation	*N*
CTCA	30.63	3.29	30
Lecture	24.83	3.63	35
Total	27.51	4.51	65

Source(s): By authors

cultural component of the CTCA as espoused by Okebukola (2020). Ausubel's theory of advanced organisers is the final theory relative to the CTCA that supports our finding. Ausubel promotes advanced organisers to connect new learning material with existing notions. This is observed in the processes of teaching using the CTCA, where students are asked to acquire prior knowledge about spreadsheets from the community, Internet sources and their environs.

Empirically, our findings are consistent with the works of Awaah (2020) and Adam (2019). The Awaah (2020) study investigated the efficacy of the CTCA in teaching politics and bureaucracy as difficult concepts in the public administration curriculum. Students in the experimental group were taught using CTCA, while the control group was taught using the traditional lecture method. Both concepts were taught in four lessons over two weeks. The PABAT assessed the students' 15 items on politics and 15 items on bureaucracy. The study's results showed that the experimental group (mean = 22.20 and SD = 5.10) significantly outperformed the control (mean = 20.45 and SD = 8.01) in politics and bureaucracy [F (1, 130) = 14.07; p = 000]. These findings show the potential of CTCA in improving undergraduate students' performance in selected difficult concepts in public administration. Similarly, Adam (2019) examined the potency of the CTCA on students' achievement and attitude towards mutation and variation. The study employed a mixed-method approach. The quantitative approach was a quasi-experimental pre-test and post-test for both the control and experimental groups. The data-gathering instruments were students' achievement tests on variation and mutation and a questionnaire on students' attitudes towards variation and mutation. He revealed a significant impact of the CTCA on students' academic achievement as experimental group students outperformed their control group counterparts taught using the lecture method on the achievement measure on the attitude towards mutation and variation.

The consistency in the findings could be attributed to the concept of indigenous knowledge. The cultural element of the CTCA espouses that students should be taught using indigenous knowledge relative to their culture. The use of indigenous knowledge prevents teachers from presenting abstract concepts in a format that students can easily grasp and understand. Kpaji and Ibrahim (2015) posits that teachers need to employ indigenous knowledge in teaching biology to prevent students from viewing the subject as abstract and boring but rather as relatable and easy to understand. This assertion is supported by Okebukola *et al.* (2016) who also assert that pre-service and in-service training of science teachers should begin to reflect more on providing teachers with some form of CTCA experience in the quest for culturally and contextually relevant methods of effective delivery of science.

Our study emphasises the significance of indigenous knowledge in teaching and learning as evident by the qualitative results. For instance, Mary (pseudonym) mentioned that she liked using the local examples to make the topic look like something she had always known. This finds support in the work of Wilson (1981) who stresses the importance of context and location in students' understanding of concepts. He posited that specific context should be pulled from the learner's immediate environment to achieve effective learning and a positive behavioural change in the learner's life.

However, students must be taught to differentiate between facts and folklore in the use of indigenous knowledge. Egerue (2019) advises that students should be careful not to allow traditional and religious beliefs to interfere with the scientific explanation of basic concepts. For example, students should be taught not to allow their indigenous spiritual beliefs to prevent them from grasping the explanations that science has provided for various natural phenomena. The disagreement might result from the small sample used for the study, and the time used to implement the approach might be too small, which led to the above findings.

Furthermore, the consistency in the findings could also be attributed to the technological and context approaches of the CTCA. For instance, Onyeka (pseudonym) asserted that he got answers from different sources online, which helped him better understand the topic. This reflects the technological bit of the CTCA and reflects the technophilosophy as espoused by Heidegger. Also, Adeyemo (pseudonym) posted that the pre-class assignments enabled him to get a base understanding of the topic before coming to class. Whiles it is noted that the pre-class assignments are related to the cultural component of the CTCA, Adeyemo's response also reflects the cultural-historical theory of Vygotsky. Vygotsky's theory also finds meaning in the response of Aishat (pseudonym) that the use of cultural examples made it easier for him to relate to the topic. Lastly, for both Abubakar (pseudonym) and Mary (pseudonym), the context pillar of the CTCA and the cultural-historic theory were evidence, as reflected in their responses "The assignments are given before class boosted my confidence, so I was able to answer questions in class which also increased my understanding" and "I liked the use of the local examples. It made the topic look like something I had always known".

Conclusions and implications

Our study proves a statistically significant difference in the achievement of the experimental and control groups. The significance favours the experimental group, implying that the CTCA is a better approach to teaching than the lecture method in enhancing students' understanding of spreadsheets in computer studies. This outcome contributes significantly to the body of knowledge, especially in Nigeria, by revealing the usefulness of the CTCA in teaching computer science-related courses so as to enhance students' achievement. It also means that adopting the CTCA for teaching and learning in the Nigerian senior high school computer studies curriculum can boost students' performance. Our findings are further significant to teaching and learning to the effect that the study's result will help researchers further evaluate the effectiveness of the CTCA on students' academic achievements in spreadsheet, which is one of the difficult topics in computer studies in Nigerian secondary schools. Again, our findings augment computer science literature on teaching models that hold the keys to understanding spreadsheets.

Lastly, in terms of practice, the CTCA must be introduced at an experimental level in computer science teaching in Nigerian secondary schools. Teachers should be encouraged to use the CTCA as a teaching model to identify particular challenges that may be peculiar to the model. This should be done after teachers have been trained in using the teaching model.

Limitations and future research

A key limitation is the relatively small sample size used, which does not allow generalisability. Also, the study was conducted only in Nigeria, constraining a holistic view of how it will apply in other regions of the world. Therefore, future studies involving large samples are necessary to test the efficacy of the CTCA in teaching computer science in Nigerian secondary schools to further establish its efficacy or otherwise. Again, because the control group was taken from one school and the experimental group was taken from another school, results may have been affected by the different cultures of learning in each. The curriculum for both schools was nearly identical and the students' academic abilities were similar, but school cultures are often not strictly comparable, even within the same neighbourhood.

Originality value

Alternative orthodox teaching methods are usually tested in breaking barriers to concept difficulties. The originality of this study is hinged on its ground-breaking test of the CTCA to the study of the spreadsheet. The findings of this study indicate its efficacy in improving students' understanding of spreadsheet and computer science education.

Abbreviations

ANCOVA	Analysis of Covariance
BECE	Basic Education Certificate Examination
COVID-19	Corona Virus Disease 2019
CTCA	Culturo-Techno-Contextual Approach
IBM-SPSS	International Business Machines Statistical Package for Social Sciences
PABAT	Politics and Bureaucracy Achievement Test
SAT	Spreadsheet Achievement Test
SD	Standard Deviation
WASSCE	West African Senior School Certificate Examination

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