Received 6 August 2022
Revised 11 October 2022
Accepted 19 December 2022

In the classroom I enhance students understanding of entrepreneurship development – the culturo–techno-contextual approach

Fred Awaah
University of Professional Studies, Accra, Ghana

Abstract

Purpose – This study aims to present a step-by-step implementation of the culturo–techno-contextual approach (CTCA) in a university classroom to teach industry and competitive analysis in the Ghanaian undergraduate entrepreneurship development curriculum. It further investigates the efficacy of the CTCA in breaking difficulties related to the study of industry and competitive analysis as a difficult concept in the Ghanaian entrepreneurship development curriculum. In doing this, the CTCA is compared with the lecture method.

Design/methodology/approach – The study adopts a quantitative approach. A quasi-experimental design is employed to gather data from 215 level 400 (4th-year undergraduate students) entrepreneurship development students at a Ghanaian public university. The experimental group was taught with CTCA, while the control group used the lecture method. The data was collected using the industry and competitive analysis achievement test (ICAAT). As random assignment to experimental and control groups were not possible, the data were subjected to an analysis of covariance approach with pre-test scores added as a covariate.

Findings – The results show that the experimental group significantly outperformed the control group. The results further indicate the efficacy of CTCA in improving undergraduate students' performance in complex concepts of entrepreneurship.

Originality/value – Researchers usually test alternative teaching methods to break down barriers to study difficulties. The study's uniqueness stems from the CTCA's ground-breaking application to the study of entrepreneurship development in a Ghanaian public university.

Keywords Entrepreneurship development, Culturo-techno-contextual approach, Difficult concepts

Paper type Research paper

Introduction

Since the mid-nineteenth century, the search for more effective ways to boost students' performance has been compelling research. Resultant of these efforts, various teaching and learning methods, including co-operative learning (Gillies, 2016), concept maps (Schroeder *et al.*, 2018), demonstration (Ho *et al.*, 2016), analogies and metaphors (Choi and Kim, 2017), and constructivist approaches (Chen and Bonner, 2017), have all been analysed in the literature. Despite using some of these strategies in classrooms, stories of poor student performance in various nations abound in the literature of the second decade of the twenty-first century (Ejiwale, 2013; Watkins and Mazur, 2013; Smith *et al.*, 2014; d'Aguiar and Harrison, 2016; Hoeg and Bencze, 2017; Canning *et al.*, 2018). This trend is disturbing since

The author acknowledge the special assistance of Solomon Yeboah, Jessie Yao Foli, Andrew Tetteh, Dorca Adomaa Addo, Emmanuel Okyere Ekwam and Emmanuella Heloo.

Journal of Research in Innovative Teaching & Learning
Vol. 17 No. 1, 2024
pp. 100-124
Emerald Publishing Limited
2397-7604
DOI 10.1108/JRIT-08-2022-0047

these students represent the next wave of human resources required to manage and improve various facets of society.

As part of a new wave of literature regarding students' difficulties in various disciplines, researchers have recently pushed for creating and using cultural models to teach students (Awaah *et al.*, 2021a, b, c). Culture has long been employed in education research to examine equality concerns for low-income, racial and ethnic minority pupils (Theobald and Nachtigal, 1995). It has given us a perspective to appreciate classrooms as cultural spaces and see the value of students' cultural ways of being as learning tools (Seiler, 2013). The notion of cultural teaching methods is that teaching students new concepts with familiar systems will make grasping the new concepts easier. This cultural orientation underpins the Afrocentric teaching model, which emphasises digital technology in methodology and delivery in fulfilling the African continent's higher education demands (Awaah, 2020a). The Afrocentric teaching model hinges on African cultural values and draws from the wealth of knowledge from parents, elders and other relatives usually passed on to generations through oral traditions. In context, students are urged to enquire from their parents, chiefs, elders and other relatives on concepts/topics to be taught in class. To be effective, the model suggests that teachers should pre-inform students on the topic to be discussed ahead of time to enable them to enquire about the cultural perspectives of the topic from their parents, chiefs, elders and other relatives. Awaah (2020b) aptly describes the Afrocentric model in teaching concepts as a politics in the ensuing;

> Politics is not new to Africans. Before the advent of western political systems, it is common knowledge that Africans had their indigenous ways of getting into political office, majorly through the clan and chieftaincy systems. In West Africa, just as it pertained in many parts of Africa, ascending to the highest positions of a chief or head of a kingdom had criteria that one had to meet, just as it is with qualifications for being elected in modern-day political office. For instance, among the Gurune-speaking people of northern Ghana, some key qualifications included being whole-bodied, not of a questionable character, must have a wife, not impotent, must be from the royal clan, be of sound mind, and not leprous, amongst others. If one did not meet any of these criteria, such a person would be disqualified from being enskinned a chief. This aspect of indigenous criteria for qualifications into the chieftaincy office can be likened to modern-day vetting on pre-established criteria for getting into political office - like being a citizen, clean police records, declaration of assets, amongst others.

According to Okebukola (2020), students will grasp topics better if taught in their cultural context. In light of this, the culturo–techno-contextual approach (CTCA) was propounded by Okebukola in 2015 and published in 2020. CTCA is a teaching and learning method (technique) that removes many conventional obstacles to effective learning. The approach is a hybrid, combining the strengths of three frameworks: (1) the cultural context, in which all students are immersed; (2) technology-mediated communication, on which teachers and students are increasingly reliant; and (3) the geographical context, which is a unique identity of each school and plays a significant role in the examples and local case studies for science lessons (Okebukola, 2020).

Awaah *et al.* (2021) posits that Africa's poor educational performance is due to the continent inheriting colonial teaching methods foreign to the African culture. He asserts that this is primarily due to Africa's colonial history, which saw other countries colonise Africa and, as a result, influence their educational systems. After independence, colonialism's effect has continued to pervade both previously colonised and formerly colonised peoples (Licata *et al.*, 2018). The trend has led to assertions that Ghana's cultural diversity is dwindling (Awaah, 2014). Music, dancing, the arts, language, food, clothing, stories, folklore and family structures are all nearing extinction. Cultural isolation has insidiously seeped into African classrooms with the adoption of non-African texts and teaching techniques. Despite these claims, there appears to be some promise for African-led teaching methodologies, focussing on the CTCA, which was developed to reduce learning challenges (Awaah *et al.*, 2021).

The efficacy of the CTCA in improving students understanding of concepts has been proven in some disciplines (Okebukola *et al.*, 2016; Adam, 2019). Despite the CTCA's widespread application in the sciences, there is no study testing the model's strength in teaching and learning entrepreneurship development, especially in an African setting. With the growing importance of entrepreneurship development to the African continent, entrepreneurship education will benefit from a culturally oriented teaching method to improve students' understanding of the course materials/concepts. Entrepreneurship development is an undergraduate course taught within Ghanaian universities.

In Ghana, the number of entrepreneurs is increasing, as in many emerging economies (Darko and Koranteng, 2015). Mainly, small and medium enterprise entrepreneurs have provided 70% of Ghana's Gross Domestic Product (GDP) and 85% of manufacturing sector employment (Darko and Koranteng, 2015). Despite its growing importance and efforts to improve student entrepreneurship, few studies are targeted at testing the efficacy of indigenous teaching methods on students' understanding of entrepreneurship development. This study aims to fill this gap.

The study aims to determine whether there is a statistically significant difference in accomplishment in "industrial and competitive" analyses between students taught using the CTCA and those taught using the lecture approach. The choice of this topic hinges on the student's perception that it is difficult to understand. In response to this problem, the study aims to answer the question: Is there a statistically significant difference in industry and competitive analysis achievement between students taught using the CTCA and those taught using the lecture method?

The work contributes significantly to the literature on entrepreneurship development, particularly in industry and competitive analysis (the most difficult concept in the entrepreneurship curriculum per the finding of this study). First, applying the CTCA to the study of industry and competitive analyses adds a component that will assist educational managers in establishing cultural methodological mitigation measures in the study of the topic in Ghanaian institutions.

The rest of the study is divided into five sections. Theoretical framework and empirical studies using CTCA' look at the literature and draws a conceptual framework; methodology is devoted to the research design and approach adopted for the study. Results and discussions look at the study's findings and discussions. Finally, we conclude and indicate the implications of our findings.

The culturo–techno-contextual approach

The CTCA is a teaching method based on culture, technology and context (Okebukola, 2020). Kwame Nkrumah's ethnophilosophy for culture, Martin Heidegger's technophilosophy for technology and Michael Williams contextualism for the contextual element of CTCA are the relevant philosophies on which the method is based (Okebukola, 2020).

According to Okebukola (2020), Ethnophilosophy is the study of indigenous philosophical systems. The implied premise is that a society's culture might have a philosophy that does not apply to all people and civilisations worldwide while sharing parallels with other cultures (Awaah *et al.*, 2021a, b, c). The CTCA asserts that teaching African students using their culture is imperative since non-African methods do not always apply to their specific living conditions (Okebukola, 2020). In using the CTCA, he asserts that students are encouraged to enquire from their parents, guardians and elders in the community on cultural knowledge relative to concepts to be taught in class as prior knowledge before the subject is taught. He argues that to achieve this, the teacher needs to inform the students ahead of time about the concept/topic to be taught before teaching the concept/topic.

The "techno" component of CTCA is based on "Heideggerian" philosophy. For Heidegger, "enframing" [Gestell in German] is using technology to turn nature into a resource for efficient use. Based on this philosophy, the CTCA advocates using modern technology available to students (Awaah *et al.*, 2021a, b, c). Modern technology like the Internet, personal computers and mobile phones enables students to find information better and makes lessons easily accessible. The CTCA encourages teachers, with the support of parents and educational institutions, to adopt technology to support students understanding of courses. This entails the willingness of parents and institutions of learning to provide technology aids such as computers, laptops, Internet and other technology support infrastructure to aid teaching and learning. The final leg, on which CTCA stands, the context, is based on Contextualism (Okebukola, 2020). Contextualism asserts that our acts, utterances, expressions and learning can only be understood in the context they occur (Okebukola, 2020). Therefore CTCA posits that in teaching students, the materials should be relevant to their immediate environment to quickly understand the concepts being taught (Okebukola, 2020). The approach links learning and communities with the main goals of increasing student engagement, boosting academic outcomes, impacting communities and promoting appreciation of the surrounding world (see Figure 1).

Theoretical underpinning of the CTCA

Vygotsky's cultural-historical theory observed the Marxist notion of tool invention's impact on human mental life and the anthropological perspective of culture's function in human evolution via dialectical synthesis (Gredler, 2014). His answer was to classify cultural signals and symbols as psychological tools, which he characterised as cognitive growth instruments (Gredler, 2014). Gredler's arguments on the work of Vygotsky establish culture as a basis of cognitive development – a stance reflective of the cultural component of the CTCA. The person in society aims to adapt one's culture's symbol systems to create similar thinking (ontogeny). Here again, the position of Vygotsky, as reflected in Gredler's (2014), finds a linkage to 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 in computer science education have culturally served as transmitters of meaning and social cohesion in human lives. Vygotsky highlighted a second

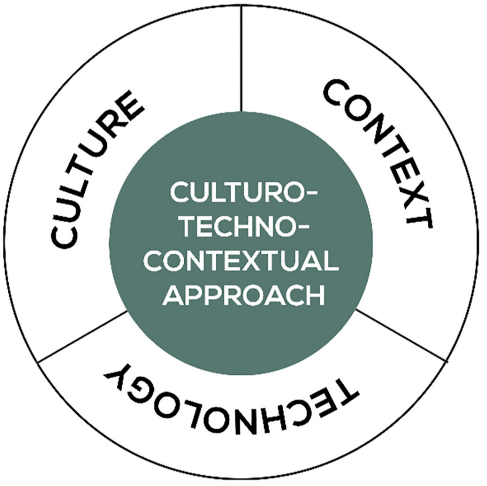

Figure 1.
The culturo–techno-contextual approach

critical role: helping people in mastering complicated cognitive skills that aren't 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.

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 as a social connection between two persons. It is then internalised as an intra-cognitive function resulting from the learner's action. The final western theory the CTCA hinges 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 a structure for the student to link the new material provided with his prior knowledge.

Related empirical literature

Several studies have been undertaken to see if the CTCA effectively improves students' understanding. Schwartz and Lederman (2002) support using indigenous knowledge systems in the classroom by claiming that many inexperienced teachers teach science in abstraction, making science lessons boring and difficult for students to grasp. Okebukola *et al.* (2016) argue that teachers who use cultural teaching approaches can break through this barrier.

Oladejo *et al.* (2022), in their study of nuclear chemistry, found a statistically significant mean difference between the groups [$F(1, 218) = 84.12$; $p < 0.05$], indicating that CTCA improved students' performance in nuclear chemistry compared to the lecture method. Also, Onowugbeda *et al.* (2022), in a study of variation and evolution in biology, found that the 76 of the students in the experimental group who were taught variation and evolution with CTCA performed better $F(1, 134) = 15.40; p < 0.0001$] than their control group counterparts ($N = 80$). Awaah *et al.* (2021a, b, c) compared the lecture method and the CTCA in the study of public administration. The result showed a statistically significant difference in the achievement of the experimental and control groups in favour of the CTCA.

In a survey of the impact of the CTCA in tackling under-achievement in difficult concepts in Biology, Okebukola *et al.* (2016) found a significant difference between the achievement of students taught with the CTCA and the lecture method, providing a basis for the efficacy of CTCA and validation of its potency. Further, Adam (2019) discovered that the CTCA impacted student achievement and attitude toward mutation and variation in Biology. He found that the CTCA substantially influences accomplishment, as experimental group students outperformed their control group peers on the achievement measure.

Indigenous knowledge must be included to bridge the gaps and voids that pupils experience in their thoughts (Awaah *et al.*, 2021). Adewusi (2020) added that students must develop a sense of cultural belonging to succeed in school. Their findings support (Wilson, 1981) that a particular context must be gathered from the local environment to achieve inclusive learning and a positive behavioural change in the learner's life for successful teaching. Learners better understand topics by questioning elders, relatives, tribes' people and friends about traditional practices related to the notion of bureaucracy in their local surroundings. Finally, Egerue (2019) warns students not to let traditional and religious views interfere with scientific explanations. In today's world, when students may be enticed to compromise the scientific world by favouring indigenous knowledge, Egerue's (2019) viewpoint is timely.

The lecture method

A significant challenge with the lecture approach is that it looks wasteful now (Rahman, 2020). Due to a lack of possibilities for students to engage in the learning process, the lecture teaching method is connected with inefficiency (Rahman, 2020). Roehl *et al.* (2013) also asserts that the lecture method is not as effective as it used to be in higher education, and educators must realise why this approach to teaching is not the most effective pedagogy available to instructors in current learning trends. Los Santos *et al.* (2016) also argue that the lecture method is D-E-A-D in every word. They explain that the lecture method is deficient in capturing students' attention, excludes a majority of 21st-century students, adds nothing to creating an engaging and supportive learning community in the classroom and diminishes student engagement in the American class.

The method has been contrasted unfavourably with other teaching and learning pedagogies, including simulations, cooperative learning and flip classroom (Safari *et al.*, 2020; Bello *et al.*, 2016; Bennett and Maton, 2010). According to Safari *et al.* (2020), the average mid-term test score for peer-teaching was much higher than the lecture technique and the average final exam. They also discovered that the average overall student impression score for peer-teaching was much higher than the similar score for lecturing.

Bello *et al.* (2016) also report that the simulation technique is a significant predictor of students' performance, as scores of students taught with the simulation game technique were much higher and better than those taught using the lecture method. Kolahdouzan *et al.* (2020) say that the case-based learning technique had better mean student satisfaction scores than the lecture method. In 21st-century classrooms, educators will not be able to teach as they did in the past. The technological integration that now pervades every part of modern life has altered how students engage with information and learn (Bennett and Maton, 2010).

Latest discussions about the potential of entrepreneurship Africa based on people's values

Entrepreneurship education aiming to foster critical citizens engaged in sustainable value creation for society must reflect on people's freedoms to develop and implement ideas based on opportunity. The sprouting entrepreneurs approach includes this perspective. Sprouting entrepreneurs is a three-year teaching programme for rural primary and secondary schools that focuses on entrepreneurship in agriculture. It addresses the South African real-life challenges of food insecurity, youth unemployment and rural poverty from a classroom

perspective by linking agriculture, food and entrepreneurship as main learning areas (Forcher-Mayr and Mahlknecht, 2020). It focuses on agriculture as a medium for developing entrepreneurship competencies within the learning context of marginalised rural schools and communities (Forcher-Mayr and Mahlknecht, 2020). The contextual thinking espoused by Forcher-Mayr and Mahlknecht (2020) finds semblance with the CTCA, which emphasises context as a key pillar for students understanding concepts in various study areas, including entrepreneurship education.

The discussed approach advocates for a wide definition of entrepreneurship education that emphasises the enlargement of individual freedoms (Forcher-Mayr and Mahlknecht, 2020). When learners without endowments in marginalised schools, in the context of a stagnating economy, inequality and mass youth unemployment, are told to become entrepreneurs, they should be able to ask and enquire: What value can I create for others? What are my freedoms to achieve? Where do my unfreedoms come from? How can I act upon them? These questions are cultural since some cultures encourage students to probe. In contrast, others discourage probing issues – a further compliment to the cultural component of the CTCA, which encourages that teaching to be in line with students' cultural values.

Methodology

Research design

This study adopted a quantitative approach. The researchers' desire to examine the efficacy of the CTCA as a teaching tool in boosting students' understanding of the industry and competitive analysis in the Ghanaian entrepreneurship development curriculum necessitated this approach (see Figure 2).

A quasi-experimental design was adopted. Specifically, Quasi-experimental designs can establish causal relationships and are most useful when randomised controlled experiments are impossible (Bärnighausen *et al.*, 2017). This is particularly important in this study as the research seeks to establish whether the CTCA can positively affect students' understanding and achievement. The pre-test post-test non-equivalent group design used in this study may be expressed as illustrated in Figure 3.

The study population

The population of the study comprised of all level 400 students studying entrepreneurship development in a Ghanaian public university.

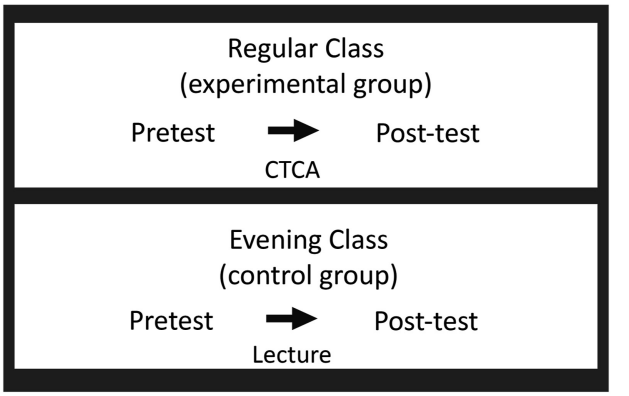

Figure 2.
Pre-test post-test non-equivalent groups design

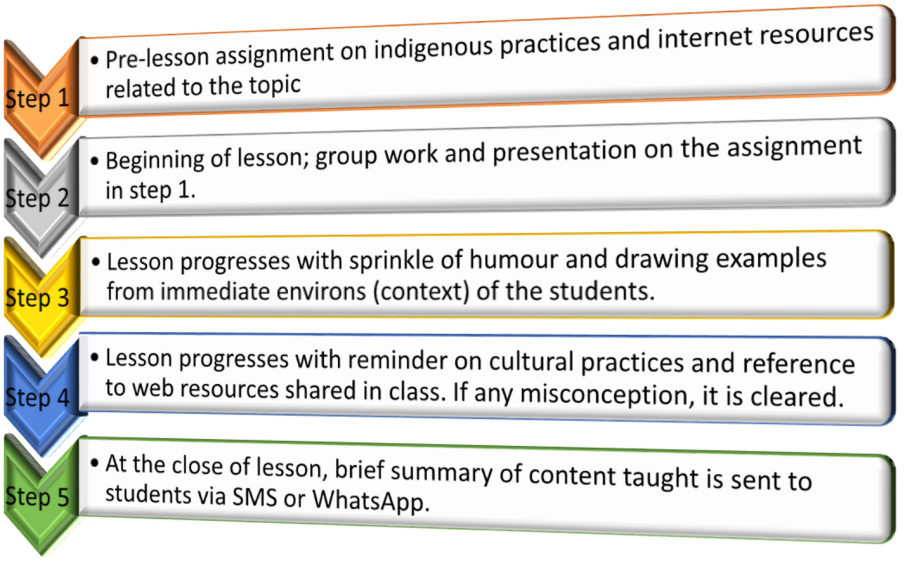

Figure 3.
Steps in teaching using the CTCA sourced from Okebukola (2020)

Sample and sampling techniques

Two entire class groups (Regular and Evening) from the selected University were sampled for this study. The classes from which the groups were drawn were chosen based on their similarity in terms of classes offering the same course and taught by the same lecturer, formal class tests and reports, and students from similar socio-cultural and economic backgrounds. The two distinct groups (Regular and Evening) consisted of two entire level 400 classes taught by the same lecture. The lecturer had been trained in the use of the CTCA.

The quasi-experimental-control group study methodology entailed selecting groups on whom the variable would be examined without using a random pre-selection technique (Awaah *et al.*, 2021a, b, c). The purposive sampling approach was used to pick level 400 entrepreneurship development (regular) courses for the experimental-CTCA group, which comprised 117 students. The same sampling procedure was used to pick level 400 entrepreneurship development (evening class) as a control group of 98 students. The study included 215 students from the sampled University. The population sample was made up of people of varying abilities and genders.

CTCA and industry and competitive analysis perspectives

The experiment was carried out within the COVID-19 pandemic. The following aspects of "industry and competitive analysis" were taught via brick-and-mortar and online modalities.

(1) Industry definitions and competitive analyses

(2) What are the benefits of conducting industry and competitor analyses?

(3) Techniques for determining the desirability of an industry

(4) Analysing rivals and the sorts of competition that new businesses encounter.

(5) Competitive intelligence sources

Lesson outline

Lesson 1: introduction. This course gave students an overview of the industry and competitive analysis. It provided definitions for industry, competitors and other terminologies. The analytical component of the intelligence cycle was also taught to the students.

Lesson 2: importance of industry and competitive analysis. Students learned why a fresh start-up firm should do a market and competitive study. After evaluating if a new venture is possible in terms of the sector and market in which it will compete, additional research is required to understand the industry's ins and outs. The study assists a company in determining whether the niche market discovered during the feasibility studies is suitable for the new venture.

Lesson 3: techniques available to assess industry attractiveness. This lesson introduced students to the many types of analysis businesses may use to establish a sector's attractiveness, including researching environmental and business trends and applying the five competitive forces model.

Lesson 4: competitor analysis, types of competitors new ventures face and competitive intelligence sources. Students were introduced to the competitive analysis grid as a tool for evaluating a company's major competitors' positioning and available options. Students were urged to seek out cultural features pertinent to the industry and competitive analysis from family, friends or other sources to enrich their learning. Learners were given extra cultural perspectives on the subject to better understand what to look for during their research and interactions with people outside of class. A summarised version of the topic is discussed in the ensuing.

Industry and competitive analyses explained

Business strategists can benefit from industry analysis, known as Porter's five forces analysis. Porter's five forces framework is a way of analysing a business's competitive operating environment. It uses industrial organisation (IO) economics to extract five dynamics that affect the competitive intensity of an industry and, its attractiveness (or lack thereof) in terms of profitability. These five forces reduce overall profitability in an "unattractive" industry. The most unappealing industry approaches "pure competition," All firms' available profits are driven to normal profit levels (Porter, 1979). The inventor of the five forces perspective is Harvard University's, Michael E. Porter. In 1979, the Harvard Business Review published the concept for the first time.

Porter's five forces analysis. The framework for the five forces analysis comprise of competitive forces. The first is industry rivalry (the degree of competition among existing firms). Under this force, industries with intense competition reduce profit potential for companies in the industry (Porter, 2008). The second is the threat of substitutes (products or services). The availability of substitute products will limit the ability to raise prices (Porter, 2008). The next is the bargaining power of buyers. Industries with powerful buyers will significantly impact prices since firms do not have significant control over prices (Porter, 2008).

Last but not least is the bargaining power of suppliers. Industries with powerful suppliers can demand premium prices and limit the firm's profit (Porter, 2008). The final one is the barrier to entry (threat of new entrants). These barriers act as a deterrent against new competitors and cement the position of existing firms in the market (Porter, 2008).

Procedure for data collection

Some course components have to be taught online due to the experiment during the COVID-19 pandemic. The following treatment technique was applied to the experimental group. The students were taught by the researcher, who was trained in the use of CTCA.

Step 1: Students were encouraged to research industry and competitive analysis by watching relevant YouTube videos and other related platforms, as well as speaking with friends, relatives, elders and family about cultural practices and views related to the issue.

Step 2: The students were advised to form groups of 10 students with a mix of talents, ages and genders before the following session, with each group selecting a leader. This was necessary to prevent the challenges of group formation in Zoom-based online classes (a techno component of the CTCA). Each group was tasked with developing a WhatsApp group for its members. Members were given 8 min to debate and share their findings on industry-related cultural practices and competitive analyses with their peers.

Step 3: The teacher welcomed the students to Zoom classroom (a techno component of the CTCA) and asked each group's leader to present and explain their indigenous/cultural knowledge outcomes in industrial and competitive analysis when the lecture began.

Solomon (pseudo name) explained the following as his group's study findings on leveraging indigenous knowledge to conduct an industry's strength, weakness, opportunities and threats (SWOT) analysis.

For instance, a palm wine tapper who owns a small piece of land on which he cultivates and tap them for wine has five children and lives in a small community full of other palm wine tappers; his strength will be the five sons he has as they would help him on the farm compared to other palm wine tappers who do not have as many kids.

His major weakness is that he has a smaller piece of land than other palm wine tappers. In a jovial manner, opportunities arrive when a palm wine tapper dies, and his threats would be more young people getting into the tapping of palm wine.

This energised the class and set the tone for the rest of the presentations.

Step 4: The teacher then instructed the leaders of each group to send their gathered, summarised ideas through email or WhatsApp. This was a requirement following the lesson.

Step 5: Based on relevant indigenous customs, the teacher built on the lesson (producing palm wine within festive seasons will give a tapper more advantages than producing palm wine within non-festive seasons). He also clarified some of the students' mis-interpretations of traditional knowledge.

Step 6: The teacher broadened the students' fundamental understanding by connecting contextual examples from the class, school and local region to industry and competitive analyses.

Step 7: The teacher summarised the lesson with the students, posted the summary to a general WhatsApp group formed by the students in fewer than 320 characters and requested each student to read it.

The lecture teaching approach was utilised to teach Level 400 students in the control group utilising the following process. The same teacher also taught the control group.

Step 1: The teacher explained the concept of "industry and competitive analysis" and its meanings to the students

Step 2: The teacher discussed competitive and industry research benefits.

Step 3: The teacher discussed the strategies for assessing the attractiveness of an industry.

Step 4: The teacher discussed several sources of competitive intelligence.

Step 5: The teacher summarised the discussion by emphasising the key points.

Data analysis technique

The data from the industry and competitive analysis achievement test (ICAAT) were analysed with IBM (International Business Machines) SPSS (Statistical Package for the Social Sciences) 23, and analysis of covariance (ANCOVA) was used to test for statistical differences between the CTCA and the lecture teaching method in learning of industry and competitive analyses at an alpha level of 0.05. Pre-tests, post-tests and retention tests were conducted by means of the post-tests of the experimental and control groups compared to establish the statistical differences.

Results

The study sought to test the efficacy of the CTCA in the study of entrepreneurship development in Ghanaian universities by establishing whether or not there is a statistically significant difference in the *industry and competitive analyses* achievement of students taught using CTCA and lecture method. The study found that although the control group performed better in the pre-test with a mean score of 8.11 (Table 1), the experimental group performed better in the post-test with a mean score of 26.49 (Table 2), indicating the efficacy of the CTCA as a teaching method. Further, the ANCOVA result shows a statistically significant difference in knowledge about entrepreneurship achievement of students taught using CTCA and the lecture method [$F(1, 212) = 440.69$; $p = 000$] (see Table 3). To satisfy the basic assumptions, table 4 shows the Normality test whiles table 5 shows the Levenes test conducted in line with the study. The histogram and Q-Q tests are also seen in Figures 4 and 5.

The ANCOVA test of normality, Levene's test of equality of error variances, was conducted and found to be significant. At the same time, the histogram was approximately a normal curve (see Table 4). However, the Q–Q test was approximately perfect because the points clung to the line, a good result based on the required assumptions (see Table 5).

The normality test is not supposed to be significant but went for other assumptions test below.

The homogeneity test is not supposed to be significant but went for other assumptions test below.

Decision

Null Hypothesis 1: No statistically significant difference exists in students' achievement in entrepreneurship taught using CTCA and lecture method.

Table 1. Mean of pre-test score for experiment and lecture group

Method	Mean	*N*	Std. deviation
Lecture (control)	8.11	98	4.04
CTCA (experimental)	8.09	117	3.03
Total	8.10	215	3.52

Table 2. Post-test mean of gain score for experiment group (CTCA) and lecture group

Method	Mean	*N*	Std. deviation
Lecture method	18.81	98	3.50
CTCA	26.49	117	1.80
Total	22.99	215	4.69

Decision: Null hypothesis is rejected since a statistically significant difference was found in students' achievement in entrepreneurship development (industry and competitive analysis) taught using CTCA and lecture method.

Retention test

Three weeks following the post-test, a retention test was administered to evaluate whether the post-test findings resulted from deep or rote learning. The retention test results on students in the experimental group confirmed the CTCA's efficacy as a better teaching approach, with a mean score of 29.41 compared to the original experimental score of 26.49.

Discussion of results

Research question – Is there a statistically significant difference in the achievements in entrepreneurship development (industry and competitive analysis) between students taught using the CTCA and those taught using the lecture method?

The study sought to determine if there is a statistically significant difference in the achievements in entrepreneurship development (industry and competitive analysis) between students taught using the CTCA and those taught using the lecture method. The mean analysis and ANCOVA results skewed in favour of CTCA as an effective teaching approach over the lecture method. The mean shows 26.49 for the CTCA group and 18.81 for the control group. In contrast, the ANCOVA result shows a statistically significant difference in entrepreneurship development (industry and competitive analysis) achievement of students taught using CTCA and lecture method [F (1, 212) = 440.69; p = 000].

Dependent variable: post-test experimental and lecture group

Source	Type III sum of squares	Df	Mean square	F	Sig.	Partial eta squared
Corrected model	3199.86	2	1599.93	223.87	0.000	0.68
Intercept	15690.92	1	15690.92	2195.55	0.000	0.91
Achievement pre-test	53.45	1	53.45	7.48	0.007	0.03
Method	3149.48	1	3149.48	440.69	0.000	0.68
Error	1515.10	212	7.15			
Total	118312.00	215				
Corrected total	4714.96	214				

Table 3. Analysis of covariance on achievement post-test scores of experimental and control groups with pre-test scores as covariate

	Method	Kolmogorov-Smirnov[a] Statistic	Df	Sig.	Shapiro–Wilk Statistic	Df	Sig.
Achievement Post-test	Lecture Teaching Method	0.233	98	0.000	0.865	98	0.000
	CTCA	0.129	117	0.000	0.962	117	0.002

Table 4. Tests of normality

Dependent variable: post-test experimental group

F	df1	df2	Sig.
14.223	1	213	0.000

Note(s): [a] Statistically significant

Table 5. Levene's test of equality of error variances[a]

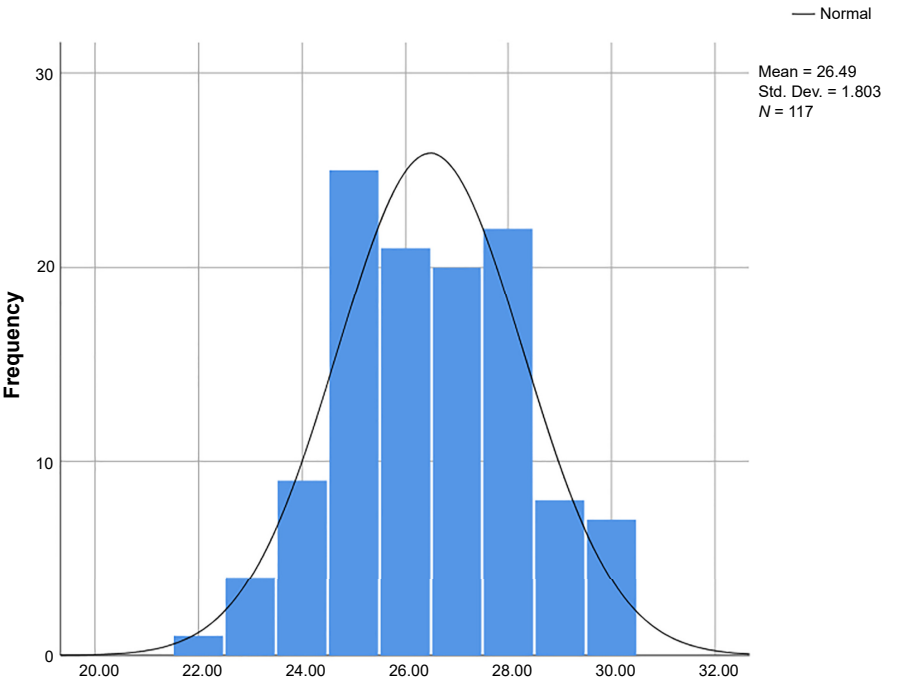

Figure 4.
Histogram

Note(s): The histogram test is approximately a normal curve; this is perfect based on the assumptions needed

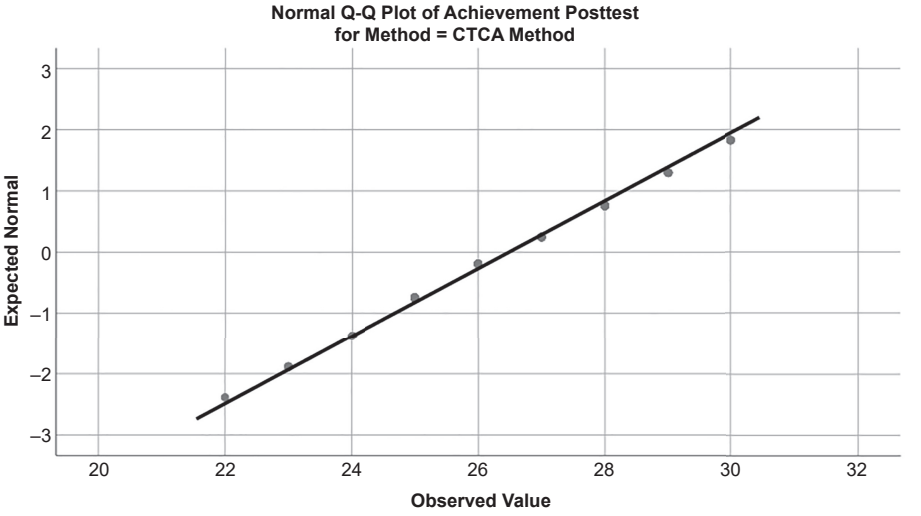

Figure 5.
Q–Q plot

Note(s): The Q-Q test is approximately perfect because the dots are clinging to the straight line; this is good and perfect based on the assumptions needed

Decision: Based on the preceding result, the null hypothesis that there will be no statistically significant difference in the achievements in entrepreneurship development (industry and competitive analysis) between students taught using the CTCA and those taught using the lecture method is rejected.

The current findings support the works of Abah *et al.* (2015); Donato-Kinomis (2016); Okebukola *et al.* (2016); Adam (2019); Awaah *et al.* (2021), while the works of Riffel *et al.* (2013) contradict the findings. Illustratively, Adam (2019) notes the CTCA has a greater influence on students' academic performance than the lecture teaching style. Similarly, Okebukola *et al.* (2016) discovered a substantial difference in accomplishment between students taught using the CTCA and students taught using the lecture technique, providing a foundation for the efficacy of CTCA and validation of its potency. Awaah *et al.* (2021) reports that learners lean heavily on their culture to shape their comprehension of whatever is being taught. As a result, it is preferable to incorporate students' traditional viewpoints into the teaching process, allowing them to perceive things from perspectives familiar to them and their indigenous surroundings, fostering greater comprehension of the concepts (Awaah *et al.*, 2021). However, students are also entreated to be objective to prevent cultural biases in their pursuit of scientific knowledge (Egerue, 2019).

The finding of Abah *et al.* (2015), Donato-Kinomis (2016), Okebukola *et al.* (2016), Adam (2019) and Awaah *et al.* (2021) confirms the works of some researchers on the weaknesses of the lecture method. Rahman (2020) criticises the method for its lack of possibilities for students to engage in the learning process; Roehl *et al.* (2013) asserts that the lecture method is not as effective as it used to be in higher education while Los Santos *et al.* (2016) assert that the lecture method is D-E-A-D in every word.

Also, Oladejo *et al.* (2022), in their study of nuclear chemistry, found a statistically significant mean difference between the groups [$F(1, 218) = 84.12$; $p < 0.05$], indicating that CTCA improved students' performance in nuclear chemistry. Further, Onowugbeda *et al.* (2022), in a study of variation and evolution in biology, found that the 76 students in the experimental group taught variation and evolution using CTCA performed significantly better $F(1, 134) = 15.40$; $p < 0.0001$] than their control group counterparts ($N = 80$). Although in the sciences and not entrepreneurial related, the study of Oladejo *et al.* (2022) and Onowugbeda *et al.* (2022) further establish the potency of the CTCA in students understanding of concepts. In a study of public administration, Awaah *et al.* (2021a, b, c) compared the lecture method and the CTCA. The result showed a statistically significant difference in the achievement of the experimental and control groups. The significance was in favour of the experimental group, implying the CTCA is a better model compared to the traditional teaching model in enhancing students' understanding of politics and bureaucracy in the study of public administration.

These findings reflect the weakness of the lecture method. According to Safari *et al.* (2020), the average mid-term test score for peer-teaching was much higher than the lecture technique and the average final exam. They also discovered that the average overall student impression score for peer-teaching was much higher than the similar score for lecturing.

On the other hand, Riffel *et al.* (2013) indicate that the total power of learning styles in explaining students' academic performance is not significant, implying that students' academic performance is not linked to learning style differences or teaching methods.

This diversity in the findings of scholars may be attributed to the differences in the environments. Therefore, for the CTCA teaching method to effectively impact students' learning outcomes, it is expected that the teacher has some basic understanding of the school's cultural setting and good knowledge of technology.

Conclusion and implications

This quasi-experimental study aimed to determine whether there is a statistically significant difference in industry and competitive analysis achievement between students taught using the CTCA and those taught using the lecture approach. The findings demonstrated a significant difference between the lecture method and the CTCA. This indicates a statistically significant difference between the experimental and control groups' achievements. The experimental group's mean score was higher, showing that the CTCA is a better model for improving students' comprehension of the industry and competitive analysis in the study of entrepreneurship development than the lecture teaching method.

The key implication of our research for practice and/or society is that learners draw heavily on their culture to shape their comprehension of entrepreneurship education. The finding also has implications for practice. Teachers (practitioners) will need to understand the course from a cultural perspective to guide students in understanding entrepreneurship.

Another implication of the study for research practice and/or society is that technology supports students understanding of entrepreneurship concepts. Therefore, teachers, parents and educational institutions encourage the use of technology to support students understanding of the course. A key implication here is that when students are encouraged to adopt existing technological tools and devices like mobile phones, computers, the Internet and social media, amongst others, to complement their study in entrepreneurship development, this will enhance their understanding of the course. This will further imply that parents, universities and guardians of students will be responsible for supporting their dependents with these technological aids to enhance learning. Finally, the context within which entrepreneurship education is being taught is critical. The school setting within which the course is taught has implications for students' understanding of the course.

This study bridges the gap between theory and practice in that while the CTCA as a theory has been explained, its applicability in the classroom has been outlined step by step. This will ensure its replicability in other environs and subjects. This implies that apart from adding to the literature on the subject area, the study is elaborate enough to ensure its outcomes are put into practice in the teaching of entrepreneurship. Finally, apart from this study, studies in other areas have justified the efficacy of the CTCA. This study may influence public policy within the Ghanaian educational sector as one that can be adopted as a teaching method to enhance students' understanding of the entrepreneurship development curriculum.

Limitations and future studies

Following our findings, there are still some gaps in the literature regarding obstacles in the study of entrepreneurship that might benefit from additional research. The effectiveness of the CTCA over the lecture approach may be influenced by age and job experience, which could have been employed as controls in this study. Future research should look at age and work experience on the CTCA's effectiveness.

References

Abah, J., Mashebe, P. and Denuga, D.D. (2015), "Prospect of integrating African indigenous knowledge systems into the teaching of sciences in Africa", *American Journal of Educational Research*, Vol. 3 No. 6, pp. 668-673.

Adam, U. (2019), "Potency of culturo-techno-contextual approach on students' achievement in and attitude towards mutation and variation", (Bachelor's Thesis), Lagos State University, Nigeria.

Adewusi, M.A. (2020), "Refractive index as a difficult topic for secondary school physics students: harnessing the power of indigenous (cultural) knowledge for its understanding", in Okebukola, P.A. (Ed.), *Breaking Barriers to Learning: The Culturo Techno-Contextual Approach (CTCA)*, Sterling, Slough and Delhi, pp. 218-229.

Awaah, F. (2014), "Emerging issues and threats to cultural security in Ghana: women and youth to the rescue", in Okebukola, P.A. (Ed.), *Women, Youth, Culture and Development in Africa*, Institute for African Culture and International Understanding, Abeokuta, Nigeria, pp. 3-17.

Awaah, F. (2020a), "Towards an afrocentric teaching model", available at: https://www.universityworldnews.com/post.php?story=20200414083021396

Awaah, F. (2020b), "Indigenous (cultural) knowledge related to the concept of politics as a difficult topic in public administration", in Okebukola, P.A. (Ed.), *Breaking Barriers to Learning: The Culturo Techno-Contextual Approach (CTCA)*, Sterling, Slough and Delhi, pp. 182-192.

Awaah, F., Arkorful, H., Foli, J., Darteh, D.O. and Yeboah, S. (2021a), "Previous knowledge and difficulties in the study of public administration among undergraduates in African universities", *SN Social Sciences*, Vol. 1 No. 4, pp. 1-22.

Awaah, F., Okebukola, P., Alfa, A.A., Anagba, K., Yeboah, S. and Arkorful, H. (2021b), "Developing Public Administration Education by focusing on difficult key concepts: the case of Nigeria and Ghana", *Social Sciences and Humanities Open*, Vol. 4 No. 1, pp. 100-136.

Awaah, F., Okebukola, P.A., Ebisin, A., Agbanimu, D., Peter, E.O., Ajayi, O.A., Olasunkanmi, G.A., Onyewuchi, F.A., Oladejo, A.I., Adewusi, M.A., Ademola, I., Onowugbeda, F., Odekeye, T. and Lawal, R. (2021), "Influence of gender and career interest on African university students' perceived difficult concepts in the study of public administration", *Teaching Public Administration*, Vol. 39 No. 2, pp. 227-245.

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

Bärnighausen, T., Tugwell, P., Røttingen, J.A., Shemilt, I., Rockers, P., Geldsetzer, P. and Atun, R. (2017), "Quasi-experimental study designs series—paper 4: uses and value", *Journal of Clinical Epidemiology*, Vol. 89, pp. 21-29.

Bello, S., Ibi, M.B. and Bukar, I.B. (2016), "Effect of simulation techniques and lecture method on students' academic performance in Mafoni Day Secondary School Maiduguri, Borno State, Nigeria", *Journal of Education and Practice*, Vol. 7 No. 23, pp. 113-117.

Bennett, S. and Maton, K. (2010), "Beyond the 'digital natives' debate: towards a more nuanced understanding of students' technology experiences", *Journal of Computer Assisted Learning*, Vol. 26 No. 5, pp. 321-331.

Canning, E.A., Harackiewicz, J.M., Priniski, S.J., Hecht, C.A., Tibbetts, Y. and Hyde, J.S. (2018), "Improving performance and retention in introductory biology with a utility- value intervention", *Journal of Educational Psychology*, Vol. 110 No. 6, p. 834.

Chen, P.P. and Bonner, S.M. (2017), "Teachers' beliefs about grading practices and a constructivist approach to teaching", *Educational Assessment*, Vol. 22 No. 1, pp. 18-34.

Choi, H.H. and Kim, M.J. (2017), "The effects of analogical and metaphorical reasoning on design thinking", *Thinking Skills and Creativity*, Vol. 23, pp. 29-41.

d'Aguiar, S. and Harrison, N. (2016), "Returning from earning: UK graduates returning to postgraduate study, with particular respect to STEM subjects, gender and ethnicity", *Journal of Education and Work*, Vol. 29 No. 5, pp. 584-613.

Darko, E. and Koranteng, K. (2015), *Social Enterprise Landscape in Ghana*, British Council, Ghana, Accra.

Donato-Kinomis, X.G. (2016), "Indigenous knowledge systems and practices (IKSPs) in the teaching of science", *13th National Convention on Statistics (NCS)*, pp. 1-8.

Egerue, I.C. (2019), *Impact of Socio-Cultural Factors on Scientific Explanations in Genetics and Ecology Offered by Senior Secondary Students in Lagos State (Doctoral Dissertation)*, Lagos State University, Lagos, Nigeria.

Ejiwale, J.A. (2013), "Barriers to successful implementation of STEM education", *Journal of Education and Learning*, Vol. 7 No. 2, pp. 63-74.

Forcher-Mayr, M. and Mahlknecht, S. (2020), "A capability approach to entrepreneurship education: the Sprouting Entrepreneurs programme in rural South African schools", *Discourse and Communication for Sustainable Education*, Vol. 11 No. 1, pp. 119-133.

Gillies, R.M. (2016), "Cooperative learning: review of research and practice", *Australian Journal of Teacher Education (Online)*, Vol. 41 No. 3, pp. 39-54.

Gredler, M. (2014), "Lev Vygotsky (1896–1934)-Cultural-historical theory, education and cognitive development".

Ho, M.K., Littman, M., MacGlashan, J., Cushman, F. and Austerweil, J.L. (2016), "Showing versus doing: teaching by demonstration", *Advances in Neural Information Processing Systems*, Vol. 29.

Hoeg, D. and Bencze, L. (2017), "Rising against a gathering storm: a bio political analysis of citizenship in STEM policy", *Cultural Studies of Science Education*, Vol. 12 No. 4, pp. 843-861.

Kolahdouzan, M., Mahmoudieh, M., Rasti, M., Omid, A., Rostami, A. and Yamani, N. (2020), "The effect of case-based teaching and flipped classroom methods in comparison with lecture method on learning and satisfaction of internship students in surgery", *Journal of Education and Health Promotion*, Vol. 9, p. 256, doi: 10.4103/jehp.jehp_237_19.

Licata, L., Khan, S.S., Lastrego, S., Cabecinhas, R., Valentim, J.P. and Liu, J.H. (2018), "Social representations of colonialism in Africa and in Europe: structure and relevance for contemporary intergroup relations", *International Journal of Intercultural Relations*, Vol. 62, pp. 68-79.

Los Santos, D., Bain, S., Kupczynski, L. and Bain, S. F. (2016), "The lecture method is DEAD", *FOCUS on Colleges, Universities and Schools*, Vol. 10 No. 1.

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

Okebukola, P.A.O., Ige, K., Oyeyemi, A.O.O., Owolabi, O., Okebukola, F. and Osun, G. (2016), "Exploring the impact of culturo-techno-contextual approach (CTCA) in tackling under-achievement in difficult concepts in biology", *Proceedings of the 2016 Conference of the National Association of Research in Science Teaching*.

Oladejo, A.I., Okebukola, P.A., Olateju, T.T., Akinola, V.O., Ebisin, A. and 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*, Vol. 99 No. 8, pp. 2919-2931.

Onowugbeda, F.U., Okebukola, P.A., Agbanimu, D.O., Ajayi, O.A., Oladejo, A.I., Awaah, F., Ademola, I.A., Gbeleyi, O.A., Peter, E.O. and Ige, A.M. (2022), "Can the culturo-techno-contextual approach (CTCA) promote students' meaningful learning of concepts in variation and evolution?", *Research in Science and Technological Education*, pp. 1-17.

Porter, M. (1979), "How competitive forces shape strategy" *Harvard Business Review*, Vol. 57 No. 2, pp. 137-145.

Porter, M.E. (2008), "The five competitive forces that shape strategy", *Harvard Business Review*, Vol. 86 No. 1, pp. 25-40.

Rahman, S. (2020), *Improving the Power of Lecture Method in Higher Education*, Teaching Learning.

Riffel *et al.* (2013), Riffel *et al.*, 2013 is not in the References. This is important because it is one of the few references that seems to be critical of the results presented.

Roehl, A., Reddy, S.L. and Shannon, G.J. (2013), "The flipped classroom: an opportunity to engage millennial students through active learning strategies", *Journal of Family and Consumer Sciences*, Vol. 105 No. 2, pp. 44-49.

Safari, M., Yazdanpanah, B. and Hatamipour, S. (2020), "Learning outcomes and perceptions of midwifery students about peer-teaching and lecture method in gynecology and infertility course", *Journal of Pedagogical Research*, Vol. 4 No. 3, pp. 291-298.

Schroeder, N.L., Nesbit, J.C., Anguiano, C.J. and Adesope, O.O. (2018), "Studying and constructing concept maps: a meta-analysis", *Educational Psychology Review*, Vol. 30 No. 2, pp. 431-455.

Schwartz, R.S. and Lederman, N.G. (2002), "It's the nature of the beast": the influence of knowledge and intentions on learning and teaching nature of science", *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, Vol. 39 No. 3, pp. 205-236.

Seiler, G. (2013), "New metaphors about culture: implications for research in science teacher preparation", *Journal of Research in Science Teaching*, Vol. 50 No. 1, pp. 104-121.

Smith, J.L., Cech, E., Metz, A., Huntoon, M. and Moyer, C. (2014), "Giving back or giving up: native American student experiences in science and engineering", *Cultural Diversity and Ethnic Minority Psychology*, Vol. 20 No. 3, p. 413.

Theobald, P. and Nachtigal, P. (1995), "Culture, community, and the promise of rural education".

Watkins, J. and Mazur, E. (2013), "Retaining students in science, technology, engineering, and mathematics (STEM) majors", *Journal of College Science Teaching*, Vol. 42 No. 5, pp. 36-41.

Wilson, T.D. (1981), "On user studies and information needs", *Journal of Documentation*, Vol. 37 No. 1, pp. 3-15.

Further reading

Greene, J.C. (2007), *Mixed Methods in Social Inquiry*, John Wiley & Sons, New York, Vol. 9.

Heidegger, M. (1977), *The Question Concerning Technology*, New York, p. 214.

Ivankova, N. and Wingo, N. (2018), "Applying mixed methods in action research: methodological potentials and advantages", *American Behavioral Scientist*, Vol. 62 No. 7, pp. 978-997.

Appendix 1

S/*N*	Pseudo name	Pre-test	Post-test	Gain score
1	Student 1, Male	10.00	29.00	19.00
2	Student 2, Male	6.00	19.00	13.00
3	Student 3, Female	7.00	18.00	11.00
4	Student 4, Male	8.00	16.00	8.00
5	Student 5, Male	8.00	18.00	10.00
6	Student 6, Female	6.00	19.00	13.00
7	Student 7, Female	9.00	16.00	7.00
8	Student 8, Female	9.00	18.00	9.00
9	Student 9, Female	9.00	17.00	8.00
10	Student 10, Female	5.00	18.00	13.00
11	Student 11, Female	8.00	18.00	10.00
12	Student 12, Male	8.00	16.00	8.00
13	Student 13, Female	9.00	16.00	7.00
14	Student 14, Female	9.00	16.00	7.00
15	Student 15, Male	12.00	15.00	3.00
16	Student 16, Male	2.00	18.00	16.00
17	Student 17, Female	6.00	19.00	13.00
18	Student 18, Female	9.00	16.00	7.00
19	Student 19, Female	7.00	17.00	10.00
20	Student 20, Male	4.00	17.00	13.00
21	Student 21, Female	7.00	22.00	15.00

(*continued*)

Table A1. Analysis of gain score on the achievement test administered to control group using the traditional teaching method

S/*N*	Pseudo name	Pre-test	Post-test	Gain score
22	Student 22, Male	8.00	21.00	13.00
23	Student 23, Female	12.00	22.00	10.00
24	Student 24, Male	1.00	20.00	19.00
25	Student 25, Female	2.00	20.00	18.00
26	Student 26, Male	2.00	19.00	17.00
27	Student 27, Female	1.00	19.00	18.00
28	Student 28, Male	2.00	17.00	15.00
29	Student 29, Male	8.00	16.00	8.00
30	Student 30, Female	9.00	17.00	8.00
31	Student 31, Female	9.00	15.00	6.00
32	Student 32, Female	0.00	17.00	17.00
33	Student 33, Male	1.00	15.00	14.00
34	Student 34, Female	15.00	17.00	2.00
35	Student 35, Male	1.00	16.00	15.00
36	Student 36, Female	5.00	18.00	13.00
37	Student 37, Female	15.00	15.00	0.00
38	Student 38, Female	16.00	14.00	−2.00
39	Student 39, Male	12.00	13.00	1.00
40	Student 40, Female	13.00	13.00	0.00
41	Student 41, Female	13.00	29.00	16.00
42	Student 42, Female	16.00	25.00	9.00
43	Student 43, Male	8.00	24.00	16.00
44	Student 44, Female	9.00	15.00	6.00
45	Student 45, Male	9.00	17.00	8.00
46	Student 46, Female	12.00	17.00	5.00
47	Student 47, Female	10.00	17.00	7.00
48	Student 48, Female	10.00	18.00	8.00
49	Student 49, Male	12.00	19.00	7.00
50	Student 50, Female	13.00	26.00	13.00
51	Student 51, Female	12.00	24.00	12.00
52	Student 52, Female	17.00	24.00	7.00
53	Student 53, Female	12.00	26.00	14.00
54	Student 54, Male	7.00	17.00	10.00
55	Student 55, Female	8.00	18.00	10.00
56	Student 56, Female	9.00	15.00	6.00
57	Student 57, Male	9.00	16.00	7.00
58	Student 58, Female	9.00	18.00	9.00
59	Student 59, Male	10.00	19.00	9.00
60	Student 60, Female	12.00	18.00	6.00
61	Student 61, Female	9.00	19.00	10.00
62	Student 62, Female	8.00	17.00	9.00
63	Student 63, Male	9.00	16.00	7.00
64	Student 64, Female	9.00	15.00	6.00
65	Student 65, Female	7.00	17.00	10.00
66	Student 66, Male	9.00	18.00	9.00
67	Student 67, Female	7.00	19.00	12.00
68	Student 68, Male	8.00	16.00	8.00
69	Student 69, Female	8.00	16.00	8.00
70	Student 70, Female	12.00	29.00	17.00
71	Student 71, Female	13.00	27.00	14.00
72	Student 72, Male	14.00	26.00	12.00
73	Student 73, Female	15.00	25.00	10.00
74	Student 74, Female	8.00	19.00	11.00
75	Student 75, Female	8.00	18.00	10.00

Table A1. (*continued*)

S/*N*	Pseudo name	Pre-test	Post-test	Gain score
76	Student 76, Female	9.00	17.00	8.00
77	Student 77, Male	6.00	19.00	13.00
78	Student 78, Male	7.00	19.00	12.00
79	Student 79, Male	8.00	22.00	14.00
80	Student 80, Female	5.00	21.00	16.00
81	Student 81, Female	8.00	20.00	12.00
82	Student 82, Female	9.00	20.00	11.00
83	Student 83, Female	9.00	21.00	12.00
84	Student 84, Female	19.00	28.00	9.00
85	Student 85, Female	8.00	21.00	13.00
86	Student 86, Male	9.00	19.00	10.00
87	Student 87, Male	8.00	18.00	10.00
88	Student 88, Male	9.00	19.00	10.00
89	Student 89, Female	8.00	18.00	10.00
90	Student 90, Female	3.00	18.00	15.00
91	Student 91, Female	2.00	17.00	15.00
92	Student 92, Female	0.00	18.00	18.00
93	Student 93, Female	2.00	19.00	17.00
94	Student 94, Male	1.00	19.00	18.00
95	Student 95, Female	1.00	18.00	17.00
96	Student 96, Female	2.00	17.00	15.00
97	Student 97, Male	8.00	16.00	8.00
98	Student 98, Female	3.00	18.00	15.00
			Mean	*10.70*

Table A1.

Appendix 2

SN	Pseudo name	Pre-test	Post-test	Gain score
1	Student 1, Male	12.00	30.00	18.00
2	Student 2, Female	2.00	28.00	26.00
3	Student 3, Female	1.00	29.00	28.00
4	Student 4, Female	2.00	28.00	26.00
5	Student 5, Female	8.00	27.00	19.00
6	Student 6, Female	9.00	26.00	17.00
7	Student 7, Female	9.00	25.00	16.00
8	Student 8, Male	12.00	25.00	13.00
9	Student 9, Male	1.00	24.00	23.00
10	Student 10, Male	13.00	27.00	14.00
11	Student 11, Female	13.00	28.00	15.00
12	Student 12, Female	14.00	26.00	12.00
13	Student 13, Male	15.00	26.00	11.00
14	Student 14, Female	11.00	25.00	14.00
15	Student 15, Female	10.00	27.00	17.00
16	Student 16, Female	10.00	25.00	15.00
17	Student 17, Female	8.00	25.00	17.00
18	Student 18, Female	7.00	24.00	17.00
19	Student 19, Female	6.00	28.00	22.00
20	Student 20, Male	9.00	27.00	18.00
21	Student 21, Male	7.00	26.00	19.00

(*continued*)

Table A2. Analysis of gain score on the achievement test administered to experimental group using the CTCA

SN	Pseudo name	Pre-test	Post-test	Gain score
22	Student 22, Female	9.00	25.00	16.00
23	Student 23, Female	12.00	25.00	13.00
24	Student 24, Male	12.00	26.00	14.00
25	Student 25, Female	10.00	27.00	17.00
26	Student 26, Female	9.00	28.00	19.00
27	Student 27, Male	8.00	26.00	18.00
28	Student 28, Female	7.00	25.00	18.00
29	Student 29, Female	8.00	27.00	19.00
30	Student 30, Male	12.00	28.00	16.00
31	Student 31, Male	14.00	27.00	13.00
32	Student 32, Female	15.00	26.00	11.00
33	Student 33, Male	6.00	29.00	23.00
34	Student 34, Female	9.00	27.00	18.00
35	Student 35, Male	6.00	26.00	20.00
36	Student 36, Male	8.00	28.00	20.00
37	Student 37, Female	12.00	27.00	15.00
38	Student 38, Female	12.00	25.00	13.00
39	Student 39, Female	12.00	25.00	13.00
40	Student 40, Female	9.00	24.00	15.00
41	Student 41, Female	8.00	26.00	18.00
42	Student 42, Male	7.00	26.00	19.00
43	Student 43, Female	8.00	28.00	20.00
44	Student 44, Male	11.00	23.00	12.00
45	Student 45, Female	10.00	25.00	15.00
46	Student 46, Male	11.00	24.00	13.00
47	Student 47, Male	9.00	25.00	16.00
48	Student 48, Female	9.00	27.00	18.00
49	Student 49, Male	7.00	28.00	21.00
50	Student 50, Male	3.00	26.00	23.00
51	Student 51, Female	2.00	25.00	23.00
52	Student 52, Female	2.00	28.00	26.00
53	Student 53, Female	3.00	29.00	26.00
54	Student 54, Male	4.00	27.00	23.00
55	Student 55, Female	5.00	26.00	21.00
56	Student 56, Female	6.00	26.00	20.00
57	Student 57, Male	5.00	28.00	23.00
58	Student 58, Female	6.00	25.00	19.00
59	Student 59, Male	7.00	25.00	18.00
60	Student 60, Female	8.00	28.00	20.00
61	Student 61, Female	9.00	27.00	18.00
62	Student 62, Female	9.00	29.00	20.00
63	Student 63, Male	7.00	29.00	22.00
64	Student 64, Female	8.00	28.00	20.00
65	Student 65, Female	9.00	27.00	18.00
66	Student 66, Male	8.00	26.00	18.00
67	Student 67, Female	9.00	25.00	16.00
68	Student 68, Male	6.00	27.00	21.00
69	Student 69, Female	7.00	28.00	21.00
70	Student 70, Female	6.00	24.00	18.00
71	Student 71, Female	7.00	23.00	16.00
72	Student 72, Male	8.00	23.00	15.00
73	Student 73, Female	12.00	26.00	14.00
74	Student 74, Female	8.00	25.00	17.00
75	Student 75, Female	7.00	27.00	20.00

Table A2. (*continued*)

SN	Pseudo name	Pre-test	Post-test	Gain score
76	Student 76, Female	8.00	28.00	20.00
77	Student 77, Male	9.00	27.00	18.00
78	Student 78, Male	9.00	26.00	17.00
79	Student 79, Male	8.00	25.00	17.00
80	Student 80, Female	8.00	26.00	18.00
81	Student 81, Female	8.00	27.00	19.00
82	Student 82, Female	6.00	28.00	22.00
83	Student 83, Female	7.00	29.00	22.00
84	Student 84, Female	9.00	28.00	19.00
85	Student 85, Female	12.00	26.00	14.00
86	Student 86, Male	8.00	27.00	19.00
87	Student 87, Male	3.00	26.00	23.00
88	Student 88, Male	8.00	26.00	18.00
89	Student 89, Female	9.00	25.00	16.00
90	Student 90, Female	8.00	28.00	20.00
91	Student 91, Female	9.00	23.00	14.00
92	Student 92, Female	9.00	24.00	15.00
93	Student 93, Female	8.00	22.00	14.00
94	Student 94, Male	7.00	25.00	18.00
95	Student 95, Female	7.00	28.00	21.00
96	Student 96, Female	7.00	25.00	18.00
97	Student 97, Male	8.00	29.00	21.00
98	Student 98, Female	8.00	28.00	20.00
99	Student 99, Female	8.00	30.00	22.00
100	Student 100, Male	9.00	30.00	21.00
101	Student 101, Male	12.00	30.00	18.00
102	Student 102, Female	2.00	28.00	26.00
103	Student 103, Female	11.00	26.00	15.00
104	Student 104, Female	9.00	30.00	21.00
105	Student 105, Female	3.00	25.00	22.00
106	Student 106, Female	6.00	24.00	18.00
107	Student 107, Female	8.00	30.00	22.00
108	Student 108, Male	9.00	30.00	21.00
109	Student 109, Male	7.00	24.00	17.00
110	Student 110, Male	9.00	25.00	16.00
111	Student 111, Female	12.00	27.00	15.00
112	Student 112, Female	11.00	24.00	13.00
113	Student 113, Male	3.00	27.00	24.00
114	Student 114, Female	4.00	29.00	25.00
115	Student 115, Female	13.00	25.00	12.00
116	Student 116, Female	4.00	28.00	24.00
117	Student 117, Female	3.00	25.00	22.00
			Mean	*18.40*

Table A2.

Appendix 3

Table A3.
Analysis of retention test on the achievement test administered to experimental group using the CTCA

SN	Pseudo name	Retention test
1	Student 1, Male	30.00
2	Student 2, Female	29.00
3	Student 3, Female	30.00
4	Student 4, Female	30.00
5	Student 5, Female	30.00
6	Student 6, Female	30.00
7	Student 7, Female	30.00
8	Student 8, Male	30.00
9	Student 9, Male	30.00
10	Student 10, Male	30.00
11	Student 11, Female	30.00
12	Student 12, Female	30.00
13	Student 13, Male	28.00
14	Student 14, Female	29.00
15	Student 15, Female	28.00
16	Student 16, Female	29.00
17	Student 17, Female	30.00
18	Student 18, Female	30.00
19	Student 19, Female	30.00
20	Student 20, Male	30.00
21	Student 21, Male	29.00
22	Student 22, Female	29.00
23	Student 23, Female	28.00
24	Student 24, Male	28.00
25	Student 25, Female	28.00
26	Student 26, Female	29.00
27	Student 27, Male	30.00
28	Student 28, Female	28.00
29	Student 29, Female	30.00
30	Student 30, Male	30.00
31	Student 31, Male	28.00
32	Student 32, Female	28.00
33	Student 33, Male	28.00
34	Student 34, Female	29.00
35	Student 35, Male	30.00
36	Student 36, Male	30.00
37	Student 37, Female	29.00
38	Student 38, Female	30.00
39	Student 39, Female	30.00
40	Student 40, Female	30.00
41	Student 41, Female	30.00
42	Student 42, Male	30.00
43	Student 43, Female	30.00
44	Student 44, Male	30.00
45	Student 45, Female	30.00
46	Student 46, Male	30.00
47	Student 47, Male	30.00
48	Student 48, Female	28.00
49	Student 49, Male	29.00
50	Student 50, Male	28.00

(*continued*)

SN	Pseudo name	Retention test
51	Student 51, Female	29.00
52	Student 52, Female	30.00
53	Student 53, Female	30.00
54	Student 54, Male	30.00
55	Student 55, Female	30.00
56	Student 56, Female	29.00
57	Student 57, Male	29.00
58	Student 58, Female	28.00
59	Student 59, Male	28.00
60	Student 60, Female	28.00
61	Student 61, Female	29.00
62	Student 62, Female	30.00
63	Student 63, Male	28.00
64	Student 64, Female	30.00
65	Student 65, Female	30.00
66	Student 66, Male	28.00
67	Student 67, Female	28.00
68	Student 68, Male	28.00
69	Student 69, Female	29.00
70	Student 70, Female	30.00
71	Student 71, Female	30.00
72	Student 72, Male	29.00
73	Student 73, Female	30.00
74	Student 74, Female	30.00
75	Student 75, Female	30.00
76	Student 76, Female	30.00
77	Student 77, Male	30.00
78	Student 78, Male	30.00
79	Student 79, Male	30.00
80	Student 80, Female	30.00
81	Student 81, Female	30.00
82	Student 82, Female	30.00
83	Student 83, Female	28.00
84	Student 84, Female	29.00
85	Student 85, Female	28.00
86	Student 86, Male	29.00
87	Student 87, Male	30.00
88	Student 88, Male	30.00
89	Student 89, Female	30.00
90	Student 90, Female	30.00
91	Student 91, Female	29.00
92	Student 92, Female	29.00
93	Student 93, Female	30.00
94	Student 94, Male	29.00
95	Student 95, Female	30.00
96	Student 96, Female	30.00
97	Student 97, Male	30.00
98	Student 98, Female	30.00
99	Student 99, Female	30.00
100	Student 100, Male	29.00
101	Student 101, Male	30.00
102	Student 102, Female	30.00
103	Student 103, Female	30.00
104	Student 104, Female	30.00

(*continued*)

Table A3.

SN	Pseudo name	Retention test
105	Student 105, Female	30.00
106	Student 106, Female	30.00
107	Student 107, Female	30.00
108	Student 108, Male	30.00
109	Student 109, Male	30.00
110	Student 110, Male	30.00
111	Student 111, Female	28.00
112	Student 112, Female	29.00
113	Student 113, Male	28.00
114	Student 114, Female	29.00
115	Student 115, Female	30.00
116	Student 116, Female	30.00
117	Student 117, Female	28.00
	Mean	*29.41*

Table A3.

Corresponding author
Fred Awaah can be contacted at: akaphari@yahoo.com