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Gender Beliefs Framed on Culturo-Techno-Contextual Approach About Learning of Difficult STEM Concepts in African Secondary Schools

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ABSTRACT

This study employed a survey and quasi-experimental design. The purpose of this study is to find out the efficacy of the lecture method, and culturo-techno-contextual approach on students' gender and attitude to logic gate. Results obtained from the survey in the first phase revealed logic gate, problem-solving skills, and machine language as the most difficult topic in computer studies. The second phase is a quasi-experimental design guided by two research questions with three public junior schools (equivalent to 8th grade) in Nigeria and Ghana. 38% (80) of the respondents were males while 62% (133) were females. Logic gate attitude (LGSAQ), and the student interview guide were used to collect data for the study. The data gathered was subjected to analysis of covariate (ancova), and the results showed no significant difference in students' gender taught using the culturo-techno-contextual approach, and the lecture method [$F(1, 210) = 2.18$; $p>.05$]. Based on the findings of the study, CTCA is recommended to computer studies teachers in Africa and beyond as a possible tool to set their teaching methods within culturally relevant and technologically appropriate contexts.

Keywords: Attitude, Gender, Culturo-Techno-Contextual Approach, STEM

INTRODUCTION

With technological developments over the past few decades, computing technology has become ubiquitous in today's world. Computer science education, as an academic discipline, is receiving increasing attention from education researchers, policymakers, and practitioners (Okebukola, 2020). Education being the lifeblood of a nation (Potokri, 2010), maybe a systematic process that yields encouraging changes within the behaviour and lifetime of humans. According to Yu, Fan, and Lin (2015), education denotes to the possession and advancement of skills and knowledge via a learning process. It "entails the passing down of information, skills, attitudes, culture, and other values from one generation to the next" (Soetan, Onojah, Alaka, & Aderogba, 2021, p.104).

The need for technological innovation has brought a revolution in the development of technological applications in education. This thus has contributed to the issue of educational systems. "Educators are fast realizing that the utilization of computer-assisted teaching and learning might thus be convenient for the users" (Ebrahimi & Jiar, 2018, p. 54).

Computer-related apps are increasingly used to support and assist children with unique educational requirements. "Information and communication technologies have taken the area of assistive technology to new heights,

opening new doors, extending perspectives, and enabling autonomy for a number of people with disabilities" (Course, 2006, p. 35). "ICT has turned the planet into a worldwide village, with an ever-increasing possibility of accessing a good array of data and knowledge, equally making it possible for sharing of written, audio and visual information at real-time in many parts of the planet" (Usang, Archibong, Aji, Eyong, & Bassey, 2018). Teachers' use of assistive technologies "broadens the range of options and opportunities for students by facilitating greater access to their educational development, exposes students and teachers to equal opportunities, and helps to level the sector by increasing students' participation in economic and human development activities" (Amesi & Yellowe, 2018, p.29).

Attitude is the strongest force affecting the status of outstanding persons including persons with disabilities. According to Soetan et al. (2021), "Students' knowledge and attitude are essential for effective use of assistive technology within the education of scholars with education needs". Assistive technology helps to extend students' participation in their educational activities. Sanchal and Sharma (2017) stated that "attitude encompasses cognitive, effective, and behavioral reactions that individuals display towards an object or their feeling".

Gender is the range of characteristics concerning and differentiating between masculinity (male) and femininity (female). Soetan, Onojah, Alaka, and Aderogba (2020) established differences between male and feminine students' efficacy within the adoption of assistive technology for learning. Amosa and Obielodan (2019) deduced differences between the scholars taught using an interactive-video instructional package and their counterparts taught using the expository method. Their analysis established that the scholars taught using interactive-video instructional packages performed better than those students taught using expository. Van Deursen (2012) reported that boys perform better than girls on ICT-related assessments. Girls, however, are reported to be spending long hours on social networking sites, taking notes of music, and online reading than boys. Although it might be perceived by more folks that males adopt technologies more than the females in their learning because the females were generally slow in adapting to technologies, but this cannot be established unless investigated. Onojah, Abimbola, Obielodan, OLumorin, Aderogba, and Adeyanju (2019) established that there is no significant difference between male and feminine undergraduate students' readiness towards the adoption of study technology for learning.

The quest for pedagogical tools that can help break the barriers to meaningful teaching and learning is on the increase. To cross this hurdle, attention is now being shifted toward culturally responsive and contextually relevant approaches. The culturo-techno-contextual approach is one of such approach. Culture and society make each other. On account of this, society makes culture thereby allowing for its preservation and transmission from the past into the future by learning. Yared and Taha (2015) posit that culture is the subtotal of the material and immaterial tools, artworks, and works of art of a people and knowledge accumulated by the people. The people's knowledge, otherwise referred to as indigenous knowledge systems are perceived as "a conglomeration of thought systems or worldviews that have evolved among various local communities over a considerable length of time. It is the product of human reflection, creativity, and resourcefulness. It is the total of organised human interactions with nature and represented in various forms: verbal, graphic or written" (Ogunniyi, 2013).

ICT as a subject has a positive impact on life-long human development as well as national development. Therefore, the subject or course must be taught by qualified teachers who can guide students toward achieving the desired educational goal. Despite that, there is a decrease in students' positive attitudes towards science, science-based careers, and gender-related cases in secondary since its inclusion in the external examination from 2014 to date. Available chief examiners' reports of basic education certificate examinations (BECE) from May/June 2018 to 2021 revealed the persistent average performance of students in the subject. The lecture method of teaching is a teacher-centric method that promotes the supremacy of the teacher within the classroom setup. Here teachers followed the drill and rote method of memorization. In this lecture method, children learn through repetition and memorization. The poor method of teaching could be a result of the continuous use of the lecture method of teaching in the classroom (Marcellinus & Johnbosco, 2019).

The study intends to explore the potency of culturo-techno-contextual approach on students' attitude, and gender in computer studies, and their perception to the methodology. The research questions are as follows:

1. Is there statistically significant difference in the attitude and gender of students in computer studies taught using culturo-techno-contextual approach? and
2. What are the perceptions of students on the culturo-techno-contextual approach?

Attitude and Gender to Science

Attitude is defined as feelings, that can be either unfavorable or favorable, positive or negative, and are typically directed towards some specific object. Attitude implies a psychological construct that is inferred from responses to a given stimuli. There are six dimensions regarding attitudes: confidence, anxiety, value, enjoyment, motivation, and expectations (Sofiani, Maulida, Fadhillah & Sihite, 2017). Gender is always a status of separation between members of society. This is particularly evident in institutions like education.

The significance of investigating students' academic performance in relation to gender is based primarily on the socio-cultural differences between girls and boys. Some duties and work are believed to be attributed to boys only. For instance, engineering, arts and crafts work, agriculture among others. And professions like catering, typing, nursing are acclimatised for women. At times parents assigned domestic functions like car washing, grass cutting, bulbs fixing and climbing ladders to fix or remove some supposed duties from the boy child. In general, it is believed that any task that is demanding or complex in nature should be handled by the boys whereas less demanding or relatively easy task should be allocated to the girls. As a result of this arbitrary way of thinking and/or belief by the larger society, girls are seen as the weaker sex. Thus, an average Nigerian girl child goes to school with these fixed stereotypes (Dania, 2014).

Also, to promote students' optimistic attitude toward science is one of the important goals of teaching science. The results of the recruitment measurement are as significant as the intellectual magnitudes. Inappropriately, cognitive domain becomes the focus of the teachers in utmost cases. The interest and attitude of students for education is indeed the mastering of concepts. Majority

of the earlier researchers have shown the important association among attitudes toward performance of science. Their submissions suggest that students with positive attitudes achieve better learning outcomes (see Sofiani, at el., 2017).

Studies such as Taye, (2021) suggest that the post-secondary education sector is still plagued by its colonial and Apartheid legacies, lack of resources, skills flight and consequent staff shortages, lack of institutional independence from the typically centralised state, and curricula that are outdated and unresponsive to Africa needs and expectations (Potokri, 2016). In the 1980s, examining students' views on the importance of science studies revealed that middle and high school students exhibit a positive attitude towards the necessity and benefit of science studies (Yager, Yager, & Lim, 2006). However, more recent studies have indicated that this interest in the importance of science classes has severely diminished at these ages, most significantly in the transfer from middle to high school (Raved & Assaraf, 2011). Chowdhury & Mahavidyalaya, (2020). showed a diversion between the science subjects considered interesting and relevant by students and those taught in high school. But the 21st century science education is drawing more attention and many scholars focus on the issue about the attitude-gender relationship in science, but there is still no consistent conclusion (Çoban, & Korkmaz, 2021). Some research (e.g., Okorie., Nwankwo, Iwuala, & Okolie, 2023) has found that inequity is systemic in science-gender related matters in schools. According to Okorie at el. (2023), science-gender related in science education does not favour equity in the teaching and learning of science.

An individual's sense of themselves as a "STEM person" is largely formed through recognition feedback. Unfortunately, for marginal individuals who engage in STEM in formal and informal spaces, this recognition often adheres to long-standing exclusionary expectations of what STEM participation entails and established stereotypes of what it means to be a STEM person. However, caregivers and parents, who necessarily share cultural backgrounds, norms, and values with their children, can play an important role in identifying their children's interest and inclination towards STEM in ways that support children's authoring of their STEM identity in the face of these downgrading discourses. The outcome of Chaffee and Plante's (2022) research, found that though this phenomenon was recounted across parent profiles. Further to this, participants (parents) narratives also reflected differences in conversation content, context, and structure based on factors associated with STEM stereotypes, including gender, formal education or training in STEM, and parents' immigration experiences.

There is something intriguing and exciting about fun or humour in teaching learning contexts. This is Memory - Dopamine, a feel-good neurotransmitter, is released when having fun. When it is released, this leads to memory stimulation. According to McChesney's work, (2016), games can motivate students to take risks. Accordingly, students that have fun are more motivated to engage with the teaching and learning process. Generally, it is seen as an individual's ability to find things funny or their ability to make people laugh (Ruch, 1998). In the context of teaching and learning, it is 'anything that the teacher (lecturer) and/or students find funny or amusing' (Bakar & Mallan, 2022). Additionally, Lomax and Moosavi (2002) noted that "humour is a pedagogical method that can be used for engaging students and for fostering concept development" (p. 13). These definitions of humour suggest that it is used not only to make people (the lecturer

and/or students) laugh, but also to enhance students' learning in the classroom.

Drawing on the above, teachers may use humor to increase both engagement in the classroom and retention of content. In order to improve learning retention, humor needs to be related to content and be appropriate. Of course, cruel, sarcastic humor should not be employed. Related humor may be received positively by students and may increase engagement, but it has not proven to increase retention of the content (Gbeleyi, Awaah, Okebukola, Shabani, & Potokri, 2022).

THEORETICAL FRAMEWORK

The culturo-techno-contextual approach is a new methodology which was invented by Peter Okebukola in 2015. It is a method of teaching and learning science designed to break down many of the traditional barriers to science (Okebukola, 2019). The strength of culturo-techno-contextual approach is its combination of three concepts which are known to be important in the learning process, namely culture, technology, and context. Teaching from the cultural and contextual perspectives of the learner and tapping the power of technology to deliver instruction are innovative as a combination in a single teaching tool. Within the context of culturo-techno-contextual approach, the philosophical drive hinged on the works of Kwame Nkrumah's ethnophilosophy and Martin Heidegger's technophilosophy. Nkrumah's ethnophilosophy espouses knowledge rooted within the ethnic environs of people – Africa in this instance. The philosophy is reflective on the "culturo" and "contextual" dimensions of culturo-techno-contextual approach which admonishes teaching and learning based on ones' cultural background.

When culturo-techno-contextual approach is being implemented, students are engaged in activities which demand that they (a) draw on their topic-relevant indigenous (cultural) knowledge; (b) use technology to seek pre-lesson knowledge of the topic to be taught; (c) work in groups to share knowledge gleaned from their socio-cultural interactions and web-based resources; (d) draw on their prior knowledge of the topic when class is in session and (e) relate lesson examples to their local contexts. Given the five orientations of culturo-techno-contextual approach, some of the following stand out when the debate or inquiry is about learning beliefs of students. These are Orientations (a), (b), (c) and (e) of culturo-techno-contextual approach because they equally fit well with Vygosky's theory of social constructivism. Orientation (a) (d) and (e) relate well with Ausubel's theory.

DESIGN/PROCEDURE

A mixed-method design was adopted for data analysis. First, the study employed a survey design to elicit information from the students regarding how they find the topics in the new computer studies curriculum, why so, and suggestions for improvement. The survey had 1,501 junior secondary computer studies students (male=734, female=767) in Nigeria and Ghana. The schools were randomly selected. The topic ranked as one of the most difficult among the 19 concepts was "Logic Gate", this was selected for the second phase. The next phase included 213 junior secondary school students (equivalent of grade 8th grade) who at the time of the study had not taken the basic education certificate examinations (BECE) to ascertain the level of potency of the methods in question. Put differently, 80 (38%) of the participants are male and 133 (62%) are females. The teaching methods, culturo-techno-contextual approach, and lecture method were used to measure the performance and critical thinking skills of students in logic gate.

A pre-test and post-test consisting of the attitude questionnaire was administered

to all groups. Participants in the experimental groups were exposed to culturo-techno-contextual approach instruction, while the control group was exposed to the same content using the traditional method of teaching. Pre-lesson assignments were given on indigenous practices and internet resources related to the topic. The logic gate attitude questionnaire and the students' perception about culturo-techno-contextual approach interview guide (SIG) was the instruments developed for the study. These instruments whose reliability and validity exercises were conducted by experts in Africa Centre of Excellence for Innovative and Transformative Stem Education (ACEITSE), Science and Technology Education (STE) department of the Lagos State University (LASU), and two computer studies teachers with experience of over ten years teaching and marking of West African Examination Council (WAEC) and Basic Education Certificate Examinations (BECE) scripts. A respectable reliability coefficient of 0.78 was obtained. Data analysis was carried out using IBM SSPS version 23. The experimental and control classes were subjected to pre-test and post-test using the same instruments. The implementation of culturo-techno-contextual approach for teaching logic gate followed the five-step culturo-techno-contextual approach protocol:

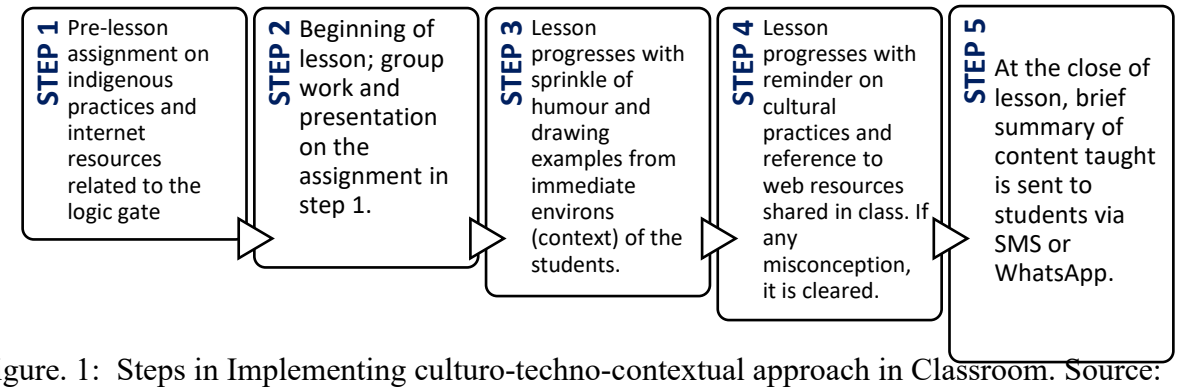


Figure. 1: Steps in Implementing culturo-techno-contextual approach in Classroom. Source: (Okebukola, 2020)

Interview guide

The logic gate computer studies interview guide was the instrument used to elicit responses from the participants who are from the randomly selected schools (public and private schools). The instrument was designed to obtain in-depth information about students' perception on the use of culturo-techno-contextual approach in the teaching and learning of logic gate. The instrument was developed to have two sections - Section A which sought demographic data of the students, and Section B which comprised three open-ended questions – to obtain the desired response on participants' perception about the culturo-techno-contextual approach. The instrument contained only three basic questions:

- List three reasons why you think the culturo-techno-contextual approach is a considerable method to be used in the class?
- Kindly explain why the cultural part of the culturo-techno-contextual approach is important?
- Suggest ways by which meaningful learning of concepts in computer studies can be made easy.

These questions were considered valid and appropriate after several practice sessions among the researchers. On account of proximity or accessibility, nine of the

participants were interviewed through phone call while five of them were interviewed face to face. In each case it took an average of seven to ten minutes to complete a session. The oral interviews were documented in form of audio clips.

ANALYSIS AND FINDINGS

A two-way ancova statistic was applied on the pre-test (as covariate) and post-test scores of the two groups on the attitude and gender items using the pretest scores as the covariate. The result shows no statistically significant difference on the attitude of students taught logic gate using the culturo-techno-contextual approach and lecture method [F (1, 210) = 2.18; p>.05].

Decision

The null hypothesis that states that there is no statistically significant difference in the attitude and gender of students taught logic gate using the culturo-techno-contextual approach and lecture method is not rejected (see table 1).

This result shows consistency with the findings from Turkish secondary school students' attitudes towards robotics and STEM that was examined in terms of gender and robotics experience (see Kucuk, & Sisman 2020). Accordingly, results showed that the students' attitudes towards robotics and STEM were positive. Gender had no effect on STEM attitudes. However, in terms of robotics attitudes, female students had significantly less desire and less confidence to learn robotics than male students. There was no gender effect on computational thinking and teamwork. Implications were discussed in terms of theoretical insights, practices for educational robotics in STEM, and directions for further research.

Table 1: Tests of Between-Subjects Effects

Dependent Variable: Post Attitude Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	43.28[a]	2	21.64	1.71	.18
Intercept	2679.98	1	2679.98	212.32	.00
Pre_Attit	16.16	1	16.16	1.28	.26
Gender	27.49	1	27.49	2.18	.14
Error	2650.70	210	12.62		
Total	142040.00	213			
Corrected Total	2693.97	212			

a. R Squared = .016 (Adjusted R Squared = .007)

Also, in exploring the attitude and interest in the gender stereotypes, Suwono, et. al., (2019 p. 012079) revealed "that male has a more positive belief in the most of STEM field, such as technology, engineering, mathematics, and STEM, rather than female". Further argued, these authors said that the emerging trends in STEM from their data suggest that both male and female have interest in the social field and medicine. However, the additional interest of male and female was significantly different in males. In this study we found that both male and female students have interest in computer science, however, their individual interest signals their attitude about the learning of

computer science as a subject. This thus indicates that students with higher interest or passion for a subject are more likely to put up a more positive attitude towards learning a subject like computer studies. This study also disclosed that the factors, namely family support, family finance, friends, teachers, and hobbies of students, determined both attitude and interest in STEM among students.

Table 2: Selections of Interview on Students' Perception on the Use of culturo-techno-contextual approach

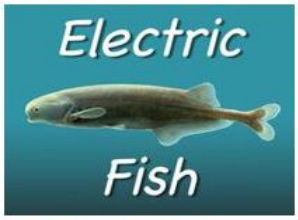
Pseudo Name	Note all data are reported unedited
Lolui	'The CTCA has helped me understand concepts such as truth table and logic inputs variables which initially seemed difficult prior to the class and I think this method will go a long way in developing students in the near future.
Azuu	'I was able to relate the concepts in logic gate to my day-to-day activities due to the cultural examples and this made things easier'.
Esormar	'Sir the teaching really helped a lot and it made us realise my potential as it helped me study ahead of the class. We are grateful for this help and I like the teaching method. Thank you, sir'.
Odoi	'The use of cultural examples made it easier for me to relate to the topic'.

Figure 2: Indigenous Knowledge illustrations used in Teaching of Logic Gate. (Source, Gbeleyi, 2022)


The Door Lock Handle "Owo Ilekun"


Fitila


Farm Layout "Ifilele Oko"



The Electric Fish "Eja Ojiji"


Koko

The School gate


Mimosa Pudica 'Sensitive Leave', Ewe Padimo.

Examples of indigenous knowledge related and found applicable to the teaching of logic gate includes eja ojiji "electric fish", serial and parallel arrangement of weeds or crops on the farmland, marble stones ''ako okuta" to spark fire in burning weeds, mimosa pudica "ewe padimo", "ogusho" to light or ignite fire in the absence of kerosene, petrol or gas, and the suwe game played by the students in secondary schools. All these are what are used in comparison with the modern technology or electricity effect of the logic gate.

In a study conducted by Ademola (2022) on the impact of culturo-techno-contextual approach (CTCA) and flipped learning on retention, problem-solving skills and attitude of secondary school students in

nuclear chemistry using a mixed method research approach, where quasi experimental research design was employed. The study which was of two phases namely survey of difficult concepts in computer studies and experimental identified difficult concepts in chemistry curriculum and the result of the survey phase being the second phrase showed that revealed logic gate, problem-solving skills, and machine language was among the first three computer studies concepts students found very difficult to learn and understand. The experimental phase had three groups, two experimental and a control. The first experimental group was taught using culturo-techno-contextual approach (CTCA) as treatment and the second experimental group was taught using the flipped method of teaching while the control group was exposed to the conventional lecture method. There were 69 students in the CTCA group (male = 28, female = 41), 54 students in the flip group (male = 25, female = 29) and 59 students in the lecture group (male = 26, female = 33).

The result obtained from the one-way mancova statistics result shows that there is a statistically significant difference in method of teaching through the multivariate F (Pillai's Trace) [$F=56.08$; $p<0.05$]. However, statistical significance difference was found on the univariate mancova on retention [$F(2,177) = 215.95$; $p>0.05$] and problem-solving skills [$F(2,177) = 11.29$; $p>0.05$]. The significant differences found in retention and problem-solving skills were in favour of CTCA group (mean = 23.77 and 11.03) respectively. For the flipped group, (mean = 12.11 and 10.73) respectively while the lecture group (mean = 10.70 and 9.11) respectively. The null hypothesis which states that there will be no statistically significant difference in retention and problem-solving skills of students taught using CTCA, flip learning and lecture method is hereby rejected since significant difference was found.

This result implies that CTCA is a method that can break down barriers to learning. Despite, the students (participants) being pre-informed of what to be taught ahead of time, this study reveals and thus suggest that CTCA encourage students to make use of the internet facilities for enquiry about the concept(s) to be learned ahead of time. This contradicts some general assumptions that students use their phones for irrelevant things such as watching porn or non-educative things. Interestingly, CTCA takes into consideration these assumptions. The good and positive use of phones by students, suggest that students are kept busy and can determine what to learn. Therefore, they have access to different learning sources and as well to many as possible elderly person about the indigenous knowledge that is related to the concepts that they are learning.

CONCLUSION

This study aimed at recommending the effectiveness of the use of culturo-techno-contextual approach in teaching and learning computer studies difficult concepts in secondary school in Nigeria. It contributes valuable insight and does have implications for teaching, learning, and researching computer studies education. The study clearly addresses, and has implications for, equity issues related to computer studies goal of helping all learners achieve science literacy, including, but not limited to, race, sex, gender expression, ethnicity, socioeconomic status, access, ability, sexual orientation, language, national origin, and/or religion.

The study revealed that there was no significant difference between students taught logic gate and their counterparts who were taught with the lecture method. Based on the findings of this study and within its limitations, we infer that there should be further probe of the methodology since

evidence has shown its impacts on other studies.

To achieve the intended quality computer science education, there is an urgent need to integrate the use of new technologies of instruction into the educational system. Among the numerous modern technologies of instruction available today is computer simulation. The use of technology to enhance learning does not only perfectly meet the needs and nature of today's learners but also serves as a prerequisite for tomorrow's world of work.

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Authors' Contributions

OAG collected all the data and conducted the analysis, wrote the literature review, methodology, results and the first draft of the article. OCP wrote most of the discussion, wrote part of the literature review and the methodology, and revised drafts of the article.

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