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Culturally Responsive Teaching (CRT) and Awareness of Own Culture: A Predictive Model for Enhancing STEM Education

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Abstract

We investigated the predictive role of culturally responsive teaching (CRT) and awareness of own culture (AOC) in improving STEM education. The researchers leveraged on the importance of CRT by exploring its direct and mediated effects on knowledge of student's culture (KSC), and patterns of cultural interaction (PCI), among STEM teachers in Southwest, Nigeria. Employing a survey research approach, 343 secondary school STEM teachers were involved. Eight hypotheses were tested for acceptance or otherwise with Smart PLS-4. Findings from the study revealed that the nuances of awareness of own culture have both direct and mediated significance on knowledge of student culture and patterns of cultural integration. The findings also reveal a direct, positive and significant impact of CRT on knowledge on students' culture and patterns of cultural integration. The study concludes that these nuances of awareness of culture can have a significant impact on the development of STEM education.

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INTRODUCTION

"Education is a process of transmitting culture in terms of continuity and growth and for disseminating knowledge either to ensure social control or guarantee rational direction of the society and the aim of Nigerian education is to inculcate national consciousness and unity, values and attitudes for the survival of in the individual and the Nigerian society (Ogbondah, 2016)".

Science Technology Engineering and Mathematics (STEM) education has been deemed crucial to the development of any nation. Literature continue to emphasize the importance of STEM, not only to the developing nations of Africa but, also to the developed nations (Onyebuchi et al., 2023; Oyeniran et al., 2023; Aina, 2022; Li et al., 2022; Li et al., 2020). The potentials of the knowledge of STEM education, is yet to be fully mined by scientist and researchers, hence the need for continuous research. In the United States of America, United Kingdom, Canada, and other developed nations, substantial amount of fund is budgeted to improve the study of science and technology. These funds are used to support research to create new innovations, better ways of doing things and for the advancement of knowledge. With these in place, emerging challenges facing STEM education up North is confronted. This has led to the continuous development of STEM, innovation and the development of STEM oriented products. The milestone currently achieved by the developed West may have been impossible if STEM education is not accorded the importance it deserves. STEM education therefore occupies a great height in the development of a nation technologically, hence, the need for the meaning teaching of STEM subjects. Literature has also established the crucial role teaching method and strategies plays in achieving meaning learning of STEM and science concepts. This situation of allocating adequate funds and giving attention to the study of STEM in the developed world, is not the same with most developing nations in Africa, especially Nigeria. These nations continue to battle with a myriad of challenges with respect to the teaching of STEM subjects.

One major challenge facing STEM education in the developing nations, is the inability to have a perfect method of instruction or teaching method (Bada & Jita, 2023; Bada & Akinbobola, 2022; Bada, 2022; Bada & Akinbobola, 2020; Akinbobola & Bada, 2018; Bada & Akinbobola, 2017). The search for a suitable method for instruction is not only limited to Nigeria but it also a concern to other nations of Africa. Hernandez (2022) reports that educators are in constant search for methods that can instil hope and inspiration on the students. The choice of a teaching method to be used for instruction depends on several factors about the teacher and the learners. Some of these factors include the curriculum content, age of learners, cognitive level of learners, background of both teachers and learners, and the experiences of the learners to mention a few. Studies reveal that most of the previous and strategies used for science instruction methods such as brain-based (Bada & Jita, 2023), makey-makey (Fokides & Papoutsi, 2020), computer-assisted instruction (Suleman et al., 2017), brain-based learning model (Jack et al., 2018), and simulation methods (Hursen & Asiksoy, 2015), have yielded little or no improvement to students' achievement. Out of all the methods identified in literature that has potentials to overcome the shortcomings of other methods is culturally responsive teaching (Ladson-Billings,2014). Culturally responsive teaching (CRT) also known as culturally relevant pedagogy (CRP), is one method that has been identified to have the potential of improving students' achievements in STEM and science related subjects.

Culturally relevant pedagogy (CRP) is a concept that was developed by Ladson-Billings in the year 1990, in response to the diversity experienced among learners in the classroom (Ladson-Billings, 1990). The diversity in race, nationality, and the culture experienced in the United States of America classrooms, especially among the minority nations of Africa Americans, Hispanics and native Americans, encouraged the researcher to investigate better ways to improving students' achievements using a more appropriate teaching method (Hernandez, 2022). In Africa, the classroom is extremely diverse in terms of race, culture, language and the experiences of the students. Nigeria, a West African nation and popularly referred to as the "Giant of Africa", is home to several cultures and languages. Nigeria is reported to have over 209 languages and cultures, thus emphasizing the diverse nature of the nation.

Since the classroom is a microscope of the larger society, science classroom is occupied by learners from different race and culture. The use of a teaching method that is culturally sensitive like CRT, might be able to alleviate the problem associated with the diverse nature of the classroom. Culturally responsive teaching (CRT) has been used in various studies and have been found to potentially viable to overcome the shortcomings of other instructional methods (Ladson-Billings, 1994a, 1995a, 2014)

The concept, culturally relevant pedagogy (CRP) was introduced over three decades ago by Gloria Ladson-Billings. The work of Ladson-Billings (1990) was improved on by Geneva Gay after focusing on teachers' strategies and practice. Gay (2018) framework focussed on the use of cultural knowledge, prior experiences, frames of reference, and performances styles of diverse ethnic students to explain and represent the concept known as culturally responsive teaching (CRT). Muniz (2019) described CRT as a type of teaching that considers learners, whose experiences and cultures are traditionally omitted from the conventional setting. In literature, several models such as culturally responsive teaching (Gay, 2002, 2018; Krasnoff, 2016; Muniz, 2019), culturally responsive pedagogy (Samuels, 2018; Chitpin & Karoui, 2021; Vakil et al, 2021); culturally relevant pedagogy (Ladson-Billings, 1995a, 1995b, 2006, 2014; Kowaluk, 2016; Chen, 2023). The advantages of culturally responsive teaching in improving the student's achievement in the classroom have been established in the literature. The role also played by science teachers in using the relevant teaching method for instruction, cannot be overemphasized. Therefore, the unique role played by STEM teachers and their understanding of the nuances related to culturally responsive teaching and cultural diversity needs to be known. However, little or none about STEM teachers understanding of these nuances, in other to effectively integrate CRT into instruction, especially when teaching STEM related subjects.

Culturally responsive teaching is an area that is still evolving in the research parlance. A review of recent studies is reflected in this study. Hernandez (2022) investigated how in-service USA teachers perceive their readiness to teach using CRP strategies. The study involved 20 teachers selected through purposively sampling technique and are teaching in clearly identified diverse schools. The researcher found out that even though teachers held different meanings to the definition of in-service teachers and CRP, the respondents believe that CRP recognises the different cultures of the students, and their perceptions about CRP is related to their classroom application of pedagogical practices, books, and projects. Abacioglu, et al (2020) studied the extent to which teachers' CRT practices is associated with teachers' perspective taking abilities and teachers' multicultural attitudes. Getting data from the lens of forty-three primary school teachers from Netherlands, and using a survey approach, the researchers discovered that teachers' background qualities were not related to gender, ethnic background, years of teaching, minoritized student concentration, IRI perspective taking, multicultural attitudes, culturally sensitive teaching, and socially sensitive teaching. This suggest that teachers background qualities are not mediated or affected by variables of teachers' gender, ethnic background, years of teaching and others. Their findings agreed with previous studies carried out in the USA (see Grant & Asimeng-Boahene, 2006; Robins et al, 2006; Rychly & Graves, 2012)

The investigation by Kowaluk (2016) on how learning leaders can support teachers create and deliver culturally responsive pedagogies found out that the method encourages reflective practice, which overall have positive effect on the achievement of students in the classroom. The researcher opines that reflective practice is a type of professional development that supports cultural responsiveness in the classroom. Previous studies (Osterman & Kottkamp, 2004; Osterman, 2000; Senge et al., 2012) allures to the fact that building on students' prior knowledge and experiences using culturally responsive strategy encourages deeper understanding, thus positively influencing students' behaviour. Similarly, an array of studies (see Ladson-Billings, 2013; Gunn & King, 2015; Baker, 2019; Kidwell & Penton Herrera, 2019; Hambacher, 2018; Torres-Harding et al., 2019) discovered that teachers who prioritized students' culture during instruction were able to achieve more gains from the teaching-learning process. Thus, the adoption of a culturally responsive teaching has the tendency of connecting students cultural background and experiences to real life situations, thus ensuring meaningful learning and the attainment of better grades.

Studies have indicated that there exists a relationship between culturally responsive teaching and cultural diversity. The emergence of the concept multicultural education, attest to the importance of the two concepts. Kowaluk (2016) defines multicultural education as the field of study that presents equal educational opportunities to students with reference to their social class, cultural background, race and ethnic group. Multicultural education appreciates that the classroom is typically diverse in different ways. It also plays crucial value in laying a solid foundation for the development of the learner who is a member of a social group. Kowaluk (2016) opines that multicultural education is important in eliminating oppression and injustice thus, establishing social justice. The fostering of peaceful coexistence among students and teachers have been found to be essential to the realization of classroom goals and objectives (Bada & Jita, 2022). However, the goal of the teaching-learning process might not be attained if peaceful coexistence is not sustained in the classroom. Cultural diversity in the classroom has the potential of disrupting the achievement of the goals of teaching because, it does not provide the ambient environment for learning to take place. Kowaluk (2016) study on how school leaders can support teachers to develop and deliver culturally responsive pedagogies in Canada found out that multicultural education is crucial for students to reach their full potentials in the classroom.

Cultural diversity leverages on the fact that every culture represented in the classroom is respected and given high importance. Villegas and Lucas (2007) define those cultural values as the beliefs, practices, specific norms and personal values each individual holds in the society. Since the classroom is a microsome of the society, it is important to lay emphasis on the different cultures represented by the learners during instruction. The cultural diversity in the classroom has therefore frustrated the adoption of one instruction method as the most suitable method for instruction because, of its inability to take into consideration the diverse nature of the classroom. Hence the adoption of a culturally responsive teaching, which imbibes the principle of multiculturalization might alleviate the challenge of cultural diversity. According to Beairsto and Carrigan (2004, p. 1) "multiculturalism is based on a celebration of diversity and not the pursuit of uniformity". Therefore, the use of a culturally responsive teaching might encourage the realization of common goals and objectives as against equality or uniformity.

STEM education is crucial to all nations, whether developed or developing nation. This is because it has the potentials of improving any nation both scientifically and technologically. Education generally helps in alleviating ignorance, expanding knowledge, preparing and empowering young adults for life and existence (Amaele & Ukulor, 2024). Several studies have affirmed that CRP improved students' achievement and performance (see Chen, 2023) In STEM education, the use of CRP have also improved students' achievement in the sciences. In the research carried out in Hawaiian by Kutsunai and Au (2013), children taught plants and water cycle using culturally responsive education, were able to build on their prior knowledge thus, improving their grades in school. Culturally responsive teaching and cultural diversity has shown a positive link in literature. Gay (2010) opine that CRT is a pedagogical theory that proclaims the importance of culture to education. The school and its structure is a subset of the society which the learners form a part. Culture represents the way of life of a particular group in the society and it is from which the learners derive their first experience from their parents. This way of life differs from one society to another. However, the classroom brings together these different experiences in the learners, with the intention of achieving a common goal which is learning. Learning has been defined as the relative permanent change in the behaviour of learners. For this to be realized, the adoption of a culturally responsive pedagogy might mask and reduce the differences among the learners in the classroom.

Culturally responsive pedagogy emphasizes the inclusion of learner's cultural background in all areas of learning (Ladson-Billings, 1994b). Several factors can mediate and or affect CRT/CD and learners' achievement in the classroom. One of those factors is the role played by teachers to the realization of the goals of teaching. Classroom teacher, a member of a particular culture plays a crucial role to the effective integration of CRP. Dahlan (2023) argues that teachers cultural understanding, intelligence and acceptable has the potential to alleviate learner's learning difficulties

emanating from their cultural differences. Literature reveals that other teachers' characteristics such as instruction method (Akinbobola & Bada, 2018; Bada & Akinbobola, 2017; 2020; 2022), career development (Efeoglu & Ulum, 2017), job performance and satisfaction (Gohar, 2014).

Education has been established to be associated with the culture of a particular society. According to a prolific philosopher and educationalist, Fafunwa (1974), education is defined as the cultural heritage an older generation handover to another younger generation, which makes the child or young adult develop his attitudes, abilities, skills and other forms of behaviour which are of positive value to society in which he lives. Fafunwa sees education from the traditional lens that assist learners to understand, appreciate and promote the cultural heritage of the entire community. While some studies in the developed nation have focussed on the predictive role of culturally responsive teaching and its direct, indirect and mediated impact on awareness of culture (Rhodes, 2016; DEEEC, 2024), there seems to be little or no study from the lens of Africa, especially Nigeria.

METHODS

This study therefore seeks to fill this gap by focusing on culturally responsive teaching and awareness of own culture. We explored the direct and mediated effect of two nuances of cultural diversity, that is, the knowledge of student's culture, and the patterns of cultural interaction, as a predictive model for STEM education on the awareness of student's own culture. In this study, cultural diversity represents the diversity among students in terms of culture, language, dressing, and other experiences which are unique to the development of the learner, as a member of the social group. Since meaningful learning can be easily achieved by building on the previous knowledge of the learners, the adequate adoption of CRT/CRP might make the gains of learning easier, thus improving students' grade in science, and ensuring the successful transfer of the cultural heritage from one generation to another. To successfully achieve this aim, eight hypotheses were tested for acceptance or otherwise, to ascertain the direct and mediated effect of those nuances related to cultural diversity (see Figure 1).

H_1: Culturally responsive teaching has a significant effect on awareness of own culture.

H_2: Culturally responsive teaching has a significant effect on (a) knowledge of students' cultures and (b) patterns of cultural interaction.

H_3: (a) Knowledge of students' cultures and (b) patterns of cultural interaction have significant effect on awareness of own culture.

H_4: Culturally responsive teaching and awareness of own culture is mediated by (a) knowledge of students' cultures and (b) patterns of cultural interaction.

H_5: Culturally responsive teaching and awareness of own culture is mediated by both knowledge of students' cultures and patterns of cultural interaction.

H_6: Culturally responsive teaching and patterns of cultural interaction is mediated by knowledge of students' cultures.

H_7: Culturally responsive teaching and awareness of culture is mediated by patterns of cultural interaction.

H_8: knowledge of students' cultures has significant effect on patterns of cultural interaction.

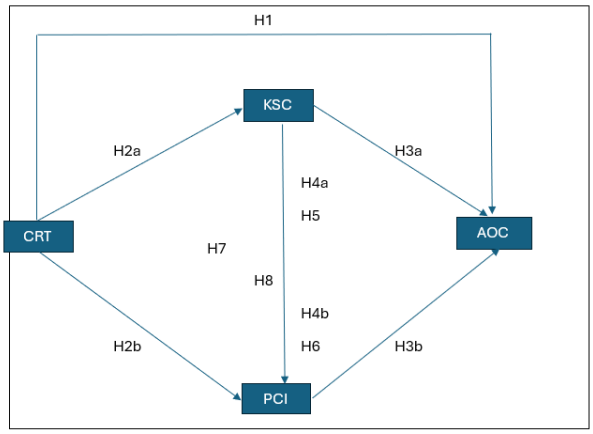

Figure 1. Conceptual model

CRT: Culturally responsive teaching
AOC: Awareness of own culture
KSC: knowledge of students' cultures
PCI: Patterns of cultural interaction

Materials

This study adopts a survey approach to examine the predictive role of CRT and AOC in improving secondary school STEM education. The direct and mediated effect of knowledge of student's culture, and the patterns of cultural interaction among science teachers in Southwest Nigeria was put into perspective. We adopt the convenience sampling technique to recruit respondents for the study. The investigation involved 343 secondary school science teachers from the five states that make up Southwest Nigeria.

Two instruments were used to obtain data for this study. First, Culturally Responsive Teaching Survey Questionnaire (CRTSQ) was adopted for use and the second, Culturally Responsive Pedagogy Self-Assessment and Reflective Conversations Questionnaire (CRPSRCQ), was also adapted. CRTSQ was adopted from the work of Rhodes (2016), on the validation of the culturally responsive teaching survey. The instrument was used originally to measure the culturally responsiveness of adult English language educators' teaching practices in the United States of America. The instrument consists of 17 statements that respondents reacted to on a 5-point Likert scale of Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SA). The ability of the instrument to measure what it is designed to measure have also been established in previous studies. Rhodes (2016) reports that the instrument has been used in various educational settings with acceptable convergent validity. The reliability of CRTSQ was also reported to be between 0.781 and 0.880. In addition, we equally subjected the instrument to both validation and reliability. Copies of the instrument were given to 3 experts in Science Education from a named university, and they all agreed that the items had the capacity to measure what it was designed for. The reliability of the instrument was achieved through test-retest by re-administering the instrument on a sample of 34 science teachers within a period of 6 weeks. A Pearson Product correlation coefficient of 0.83 attest to the fact that the instrument is reliable for use in the study.

CRPSRCQ was adapted from the Due East Educational Equity Collaboration (DEEEC, 2024) resources and printables. The survey focused on four components namely recognizing the educational impact of cultural diversity, addressing demographic inequalities in achievement, building relationships across cultural differences, and adapting curriculum to reflect cultural diversity. However, this study was limited to only section A -recognising the educational impact of cultural diversity. This section identifies, the nexus between culture and learning, and puts into perspectives teacher's cultural experiences, and the experiences of their students. The indicators for recognizing educational impact of awareness of own culture is divided into two namely, knowledge of students' cultures, and patterns of cultural interaction. The validity of CRPSRCQ was achieved by subjecting it to the validation of 3 experts in curriculum development from a university. Also, a reliability coefficient of r=0.78 achieved after test-retest attest to how consistent the instrument was.

For data collection, the two instruments were merged into one but was clearly separated into its sections (see Table 1). An electronic version of the instrument was prepared by the researchers on google form and made available via the link address https://forms.gle/xKTZxoXmimTtCA478. The link was sent out to different secondary school teacher platforms for it to be completed by the target audience in the five Southwest states of Nigeria. Also, the link was also shared on several platforms such as Whatsapp, X, facebook and through the three researcher's emails. This is to ensure wide access to a relatively large sample of secondary school science teachers across the five Southwestern states of Nigeria. A total of 343 complete responses was received and used for analysis (see Figure 2-4). The data collection took place between June 2023 and December 2023. The eight hypotheses were tested for acceptance or otherwise using Smart PLS-4.

Table 1. Culturally Responsive Teaching, Self-Assessment and Reflection Indicators for Classroom Effectiveness

S/N		Culturally Responsive Teaching Survey.
1	CRT1	I include lessons about the acculturation process.
2	CRT2	I examine class materials for culturally appropriate images and themes.
3	CRT3	I ask students to compare their culture with other cultures.
4	CRT4	I make an effort to get to know my students' families and backgrounds
5	CRT5	I learn words in my students' native language.
6	CRT6	I use mixed language and mixed cultural pairings in group work.
7	CRT7	I use peer tutors or student led discussions
8	CRT8	I use surveys to find out about my students' classroom preferences.
9	CRT9	I elicit students' experience in pre-reading and pre-listening activities.
10	CRT10	I encourage students to speak their native languages with other students.
11	CRT11	I have students work independently, selecting their own learning activities.
12	CRT12	I spend time outside of class learning about the cultures and languages of my students.
13	CRT13	I include lessons about anti-immigrant discrimination or bias.
14	CRT14	I supplement the curriculum with lessons about international events.
15	CRT15	I ask for student input when planning lessons and activities.
16	CRT16	I encourage students to use cross-cultural comparisons when analyzing material
17	CRT17	I provide rubrics and progress reports to students.
		Knowledge of Student's Culture (KSC)
18	KSC1	I create a welcoming learning environment that reflects the cultural backgrounds of my students.
19	KSC2	recognise and intervene on my own and others' predisposed expectations about student ability and performance
		Patterns of Cultural Interaction (PCI)
20	PCI1	I use various strategies to present information to students based on my knowledge of students' learning and participation styles
21	PCI2	I consistently and effectively use instructional strategies that build on students' cultural strengths and promote success.
22	PCI3	I create opportunities for students to reflect on their cultural background and share with each other.
		Awareness of Own Culture (AOC)
23	AOC1	I have an understanding of my own cultural background and how that influences my practice.
24	AOC3	I recognise and can articulate the educational impact of culture.
25	AOC4	I continuously seek professional development opportunities to explore my own and others' culture.

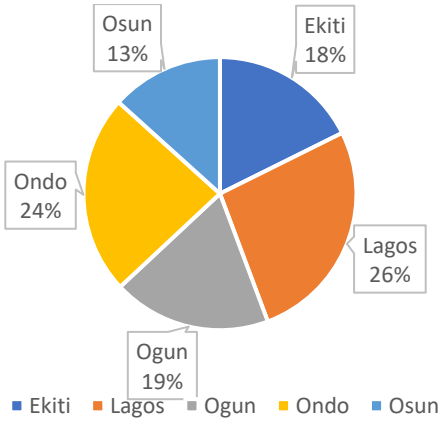

Figure 2. Respondents by State of Residence

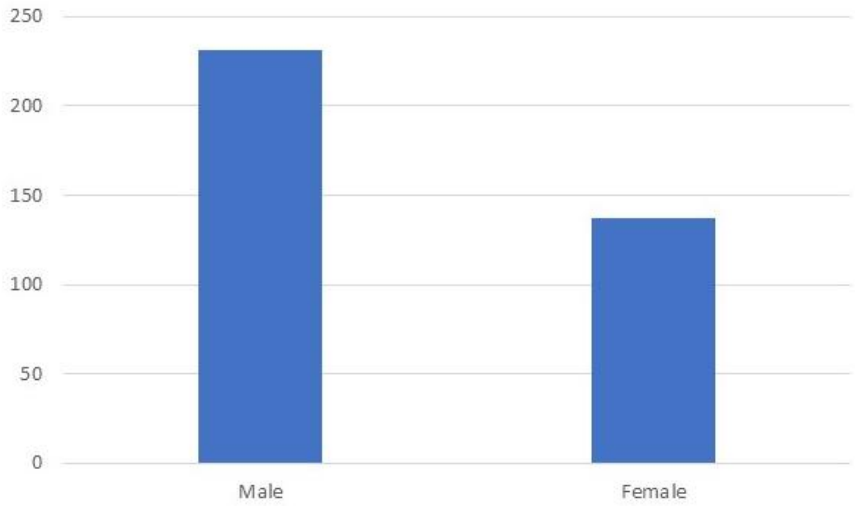

Figure 3. Respondents by Gender

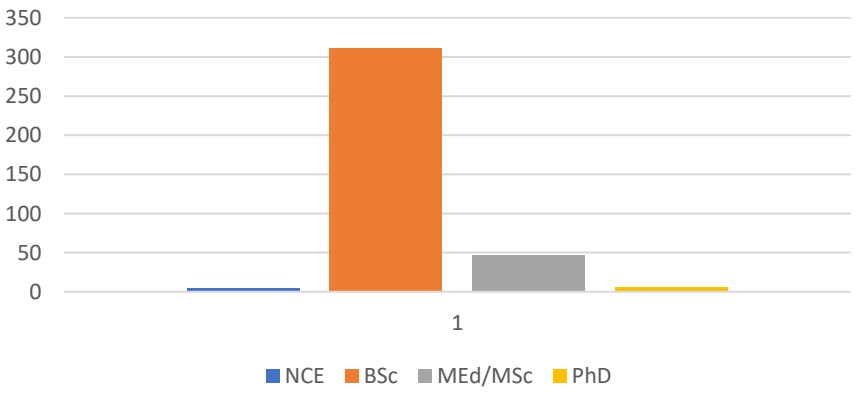

Figure 4. Respondents by Highest Degree

RESULTS AND DISCUSSION

Common method bias

We calculated the common method bias to satisfy the condition that the model is free from bias. Kock (2015) asserts that variance inflation factor (VIF) values lower than 3.33 is considered free from common method bias. Table 2 reveals that all the VIF values are lower than the benchmark value of 3.33. Hence, the model is free from common method bias.

Table 2. Collinearity statistics (VIF) Inner model

	Awareness of Culture	Culturally Responsive Teaching	Knowledge of Student Culture	Patterns of Cultural Integration
Awareness of Culture				
Culturally Responsive Teaching	1.423		1.000	1.404
Knowledge of Student Culture	2.435			1.404
Patterns of Cultural Integration	2.200			

Reliability and validity

We tested the reliability of the indicators using Cronbach's Alpha and Composite Reliability. Table 3 shows the reliability and validity for the items including their factor loadings. All except one (AOC3) have their factor loading greater than 0.600. Even though, one of the factor loadings is less than 0.600, it is not discarded because it's Cronbach's Alpha and Composite Reliability (CR) are above 0.700. This agrees with Hair et al (2019) who posits that a Cronbach Alpha and Composite Reliability above 0.700 threshold indicates that all the construct measured are reliable. All the Alpha values and CRs values are either equal or higher than the recommended value of 0.700. The Average Variance Extracted (AVE) and CRs value were all higher than 0.500 and 0.700 respectively. This result therefore buttresses convergent validity. Table 4 shows the cross-factor loadings of all the items, and we realised that all the factor loadings except one, are greater than their cross-loadings, which also buttresses discriminant validity. Table 5 also shows the discriminant validity using criterion as opined by Fornell & Larcker and the Hererotrait-Monotrait Method (HTMT).

Table 3. Item loading, reliability and validity

		Alpha	CR(rho_a)	CR(rho_c)	AVE	VIF
CRTS1	0.780	0.950	0.957	0.955	0.559	6.990
CRTS2	0.782					4.194
CRTS3	0.856					7.745
CRTS4	0.644					2.461
CRTS5	0.786					3.478
CRTS6	0.757					5.622
CRTS7	0.639					2.857
CRTS8	0.761					4.034
CRTS9	0.805					4.099
CRTS10	0.672					3.123
CRTS11	0.741					4.447
CRTS12	0.824					3.572
CRTS13	0.685					3.510
CRTS14	0.733					3.275
CRTS15	0.741					3.148
CRTS16	0.842					7.259
CRTS17	0.605					4.572
AOC1	0.744	0.697	0.808	0.820	0.552	1.620
AOC2	0.851					2.042
AOC3	0.369					1.111
AOC4	0.891					1.966
KC1	0.925	0.808	0.815	0.912	0.839	1.850
KC2	0.906					1.850
PCI1	0.838	0.872	0.883	0.921	0.796	2.117
PCI2	0.943					3.742
PCI3	0.893					2.612

Table 4. Discriminant validity – cross loading

	Awareness of Culture	Culturally Responsive Teaching	Knowledge of Student Culture	Patterns of Cultural Integration
AOC1	**0.744**	0.196	0.491	0.492
AOC2	**0.851**	0.281	0.659	0.728
AOC3	**0.369**	0.741	0.359	0.190
AOC4	**0.891**	0.518	0.790	0.803
CRTS1	0.347	**0.780**	0.403	0.352
CRTS10	0.393	**0.672**	0.308	0.337
CRTS11	0.386	**0.741**	0.456	0.346
CRTS12	0.445	**0.824**	0.500	0.488
CRTS13	0.222	**0.685**	0.274	0.216
CRTS14	0.461	**0.733**	0.428	0.336
CRTS15	0.369	**0.741**	0.359	0.190
CRTS16	0.351	**0.842**	0.363	0.347
CRTS17	0.343	**0.605**	0.260	0.212
CRTS2	0.479	**0.782**	0.515	0.449
CRTS3	0.411	**0.856**	0.421	0.453
CRTS4	0.288	**0.644**	0.268	0.245
CRTS5	0.450	**0.786**	0.445	0.453
CRTS6	0.537	**0.757**	0.461	0.385
CRTS7	0.333	**0.639**	0.294	0.102
CRTS8	0.340	**0.761**	0.361	0.366
CRTS9	0.450	**0.805**	0.492	0.305
KC1	0.789	0.543	**0.925**	0.680
KC2	0.690	0.433	**0.906**	0.665
PCI1	0.662	0.217	0.548	**0.838**
PCI2	0.754	0.447	0.687	**0.943**
PCI3	0.749	0.535	0.716	**0.893**

Table 5. Discriminant validity using the criterion by Fornell & Larcker and Heterotrait-Monotrait Method (HTMT)

	Awareness of Culture	Culturally Responsive Teaching	Knowledge of Student Culture	Patterns of Cultural Integration
Awareness of Culture	**0.743**	0.727	1.054	0.986
Culturally Responsive Teaching	0.533	**0.748**	0.592	0.474
Knowledge of Student Culture	0.810	0.536	**0.916**	0.869
Patterns of Cultural Integration	0.811	0.460	0.734	**0.892**

Note: Diagonal and bold elements are the square of the AVE (average variance extracted)
Below the diagonal elements are the correlations between the constructs (Fornell & Larcker)
Above the diagonal elements are the Heterotrait-Monotrait Method (HTMT)

Structural model

We tested the hypothesis for acceptance or otherwise. First, we began with the direct relationships. Table 6 shows the results of hypothesis 1,2a, 2b, 3a, 3b, and 8. Table 6 reveals that two hypotheses were significant and positive, while the remaining four were not significant. In clear terms, hypothesis 2a and 8 are significant, CRTS **->** KSC (β = 0.607, t = 7.324, p = 0.000); KSC **->** PCI (β = 0.809, t = 13.114, p = 0.000), while hypothesis 1, 2b, 3a, and 3b are not significant CRTS **->** AOC (β = 0.014, t = 0.133, p = 0.894), CRTS **->** PCI (β = -0.040, t = 0.744, p = 0.457), KSC **->** AOC (β = 0.657, t = 1.145, p = 0.252), PCI **->** AOC (β = 0.384, t = 0.734, p = 0.463). Therefore, hypotheses 2a and 8 are accepted while hypotheses 1, 2b, 3a and 3b are not accepted.

Table 6. Direct relationships (Hypotheses 1, 2a, 2b, 3a, 3b, 8)

	Beta B	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H_1: Culturally Responsive Teaching Survey -> Awareness of Culture	0.015	0.014	0.111	0.133	0.894
H_{2a}: Culturally Responsive Teaching Survey -> Knowledge of Student Culture	0.607	0.611	0.083	7.324	0.000
H_{2b}: Culturally Responsive Teaching Survey -> Patterns of Cultural Integration	-0.040	-0.036	0.054	0.744	0.457
H_{3a}: Knowledge of Student Culture -> Awareness of Culture	0.657	0.708	0.574	1.145	0.252
H_{3b}: Patterns of Cultural Integration -> Awareness of Culture	0.384	0.329	0.523	0.734	0.463
H_8: Knowledge of Student Culture -> Patterns of Cultural Integration	0.890	0.887	0.068	13.114	0.000

Mediation analysis

We equally analysis the mediated relationship between the variables. Table 7 shows the mediation results for hypothesis 4a, 4b, 5, 6, 7. All the hypotheses except one are positive and significant. The mediating roles of Knowledge of Student Culture, KSC (β = 0.228, t = 6.351, p = 0.000); Patterns of Cultural Integration, PCI (β = 0.312, t = 4.618, p = 0.000); Knowledge of Student Culture and Patterns of Cultural Integration, KSC & PCI (β = 0.163, t = 4.857, p = 0.000); and Knowledge of Student Culture, KSC (β = 0.042, t = 1.857, p = 0.000) was significant while the mediating role of Patterns of Cultural Integration, PCI (β = 0.042, t = 1.857, p = 0.063) was not significant. Therefore, hypotheses 4a, 4b, 5, 6 are accepted, while hypothesis 7 was not accepted.

The study examined the predictive role of culturally responsive teaching and awareness of own culture by exploring its direct and mediated effects through knowledge of student culture (KSC) and patterns of cultural integration (PCI) among STEM secondary school teachers in Southwest Nigeria. Findings from the study reveals that there is no positive relationship between culturally responsive teaching and awareness of own culture, or between culturally responsive teaching and patterns of cultural integration, supporting previous studies (Abacioglu, et al. 2020; Grant & Asimeng-Boahene, 2006; Robins et al, 2006; Rychly & Graves, 2012). This finding aligns with previous studies carried out in the USA that teacher ethnic background and years of teaching may not mediate students' achievement during lessons.

Culturally responsive teaching was found to have significant impact on Knowledge of Student Culture and Patterns of Cultural Integration. This result agrees with previous studies (Kowaluk, 2016; Osterman & Kottkamp, 2004; Osterman, 2000; Senge et al., 2012). The researchers emphasize the importance of knowing learners culturally knowledge to encourage deep understanding and influence learners' behaviour. Culturally responsive teaching is also found to have significant effect on

awareness of culture when jointly mediated by knowledge of student culture and patterns of cultural integration, or when mediated only by knowledge of student culture or patterns of cultural integration. This result agrees with Osterman & Kottkamp (2004), Osterman (2000) and Senge et al. (2012). Findings from this study reveals a significant relationship between knowledge of student culture and patterns of cultural integration, or knowledge of student culture and awareness of culture when mediated by patterns of cultural integration. However, the result reveals no significant relationship between patterns of cultural integration and awareness of culture.

Table 7. Mediating relationship (Hypotheses 4a, 4b, 5, 6, 7)

	Beta β	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H_{4a}: Culturally Responsive Teaching Survey -> Knowledge of Student Culture -> Awareness of Culture	0.228	0.226	0.036	6.351	0.000
H_{4b}: Knowledge of Student Culture -> Patterns of Cultural Integration -> Awareness of Culture	0.312	0.305	0.068	4.618	0.000
H_5: Culturally Responsive Teaching Survey -> Knowledge of Student Culture -> Patterns of Cultural Integration -> Awareness of Culture	0.167	0.163	0.034	4.857	0.000
H_6: Culturally Responsive Teaching Survey -> Knowledge of Student Culture -> Patterns of Cultural Integration	0.367	0.361	0.042	8.744	0.000
H_7: Culturally Responsive Teaching Survey -> Patterns of Cultural Integration -> Awareness of Culture	0.042	0.043	0.023	1.857	0.063

CONCLUSION

STEM education is crucial to the continuous development of any nation technologically. This study contributes to our understanding of some constructs that have not been extensively explored in previous literature relating to culturally responsive teaching and awareness of own culture, especially for a nation like Nigeria. The results from this study have provided clearer evidence on culturally responsive teaching and awareness of own culture, and through the mediating effect of knowledge of student culture and patterns of cultural integration. The focus on culturally responsive teaching is because of its potential to enhance meaningful learning of STEM subjects, which is crucial to the development of a nation technologically. The result from this study reinforces the direct significant effects of knowledge of student culture and patterns of cultural integration.

However, the direct non-significant effects of Knowledge of students' culture and patterns of cultural integration was recorded. This has great implications for the teaching and learning of STEM subjects with the use of culturally responsive teaching and its nuances. In similar version, the mediating significant and non-significant effects of Knowledge of students' culture and patterns of cultural integration was recorded. This implies that the nuances on culturally responsive teaching can affect the teaching and learning of STEM subjects either way, depending on the associated factors or on how culturally responsive teaching is handled. The findings from this paper contributes to knowledge by establishing empirical evidence of the nuances of culturally responsive teaching on the teaching and learning of STEM subjects, by viewing it direct and mediated effects from the lens of STEM teachers.

This study has some limitations. First, this present study focussed on one geopolitical zone of Nigeria whereas, there are six geopolitical zones in the country. Also, the number of the sample used is relatively small when compared to the total population of interest. To know the impact of culturally responsive teaching in more depth, future

study might include more zones or even investigate all the six geopolitical zones of Nigeria. Second, the study was based on hypothesis testing through survey data. Future studies may focus on longitudinal data that could help ascertain the dynamic change of culturally responsive teaching, knowledge of student culture, patterns of cultural integration, and awareness of own culture. Third, the mediating roles used in this study are limited to two variables. Future research can have more mediating roles investigated to ascertain their effect on culturally responsive teaching and awareness of student culture. Finally, we did not assess the role of moderating variable. Future investigation might assess the role of moderating variable, to ascertain their impact on the nuances of culturally responsive teaching and awareness of own culture.

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