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CULTURALLY RESPONSIVE PEDAGOGY AND STEM EDUCATION IN THE NIGER DELTA

BY

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Abstract

This study employed a descriptive research design to investigate the impact of culturally responsive pedagogy (CRP) on STEM education outcomes in secondary schools across the Niger Delta region of Nigeria. The target population for this study consisted of approximately 6,000 school principals in the Niger Delta states, including Bayelsa, Delta, Rivers, and Akwa Ibom. A purposive random sampling technique was used to select 460 principals as participants. The inclusion criteria required that participants hold a science-related degree and have experience teaching science subjects before their promotion to administrative roles. This sampling strategy ensured that respondents had relevant backgrounds in STEM education, enhancing the validity of insights related to culturally responsive pedagogy. Data were collected using a structured questionnaire titled "Culturally Responsive Pedagogy and the Role of School Administrators in Promoting STEM Learning Questionnaire (CRPRSAPSTEMLQUE)," which included demographic questions and a series of Likert-scale items. A pilot test with 30 principals in Anambra state yielded a reliability coefficient of r = 0.89, demonstrating strong internal consistency. Data collection was conducted via a Google Form shared through WhatsApp platforms, resulting in a 100% response rate. Descriptive statistics provided insights into respondent agreement levels, and a t-test was used to analyse the hypothesis at a 0.05 significance level. Findings suggest that integrating CRP enhances student engagement and performance in STEM subjects, with school administrators showing general commitment to its implementation. However, variability in challenges and opportunities across states was observed, highlighting the need for tailored strategies to support effective CRP integration in STEM education.

Keywords: STEM education, Responsive pedagogy, School and Principals Commitment

Introduction

Science, Technology, Engineering and Mathematics (STEM) are considered the basis of modern-day societal advancement (Khalifa et al., 2021). Thus, preparing leaners at early stage of schooling should be the concern of all stake holders in the school system. Meanwhile, there are instances where the cultural practice and social awareness of people has helped them excel in STEM subjects (O'Leary et al., 2020; Eze, 2021). Despite its potential to contribute to national and global innovation, the Niger Delta region struggles with low STEM engagement and achievement among students due to socio-economic disparities, inadequate resources, and cultural disconnects in the educational process. Addressing these issues requires a transformative approach that acknowledges the region's unique socio-cultural context while fostering academic excellence (Gay, 2020). Culturally responsive pedagogy (CRP) offers a promising framework for bridging this gap with strong emphasizes on the integration of students' cultural backgrounds into teaching practices, create more inclusive and engaging learning environments. This approach has become critical for making STEM education relevant and accessible to learners from diverse cultural and linguistic backgrounds. By connecting STEM concepts to local knowledge, traditions, and real-world applications, educators can enhance students' interest, understanding, and performance in STEM disciplines (Ladson-Billings, 2021; O'Leary et al., 2020).

The school principals, who are considered immediate administrators should therefore play a pivotal role in implementing culturally responsive pedagogy for STEM education. As leaders and decision-makers, they are responsible for creating an enabling environment that supports culturally inclusive practices, fosters teacher professional development, and aligns curriculum goals with community needs. Administrators also serve as advocates, bridging the gap between policy and practice, and ensuring that resources, policies, and programs are effectively tailored to the unique challenges of the Niger Delta region (Khalifa et al., 2021). This study is concern with the commitment of school administrators particularly, the school principals in promoting culturally responsive pedagogy to improve STEM education in the Niger Delta. It highlights strategies for integrating cultural relevance into STEM curricula, fostering teacher capacity, and engaging stakeholders to create a sustainable and impactful educational framework. By leveraging the strengths of the region's cultural heritage, school administrators can

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drive a transformative agenda for STEM education, equipping students with the skills and knowledge to thrive in a globally competitive landscape.

Culturally responsive pedagogy has been extensively studied for its impact on STEM education. Hammond (2020) argues that CRP enhances student engagement by connecting STEM concepts to students' lived experiences, thereby fostering deeper understanding and motivation. Sleeter (2021) underscores the importance of professional development for teachers, enabling them to integrate CRP effectively into their instructional strategies. Nasir et al. (2022) highlight the significance of culturally relevant STEM curricula, which incorporate indigenous knowledge systems to make learning more relatable and impactful. These studies emphasize the transformative potential of CRP in creating equitable and inclusive STEM education environments. School administrators play a pivotal role in implementing culturally responsive pedagogy. Khalifa et al. (2021) highlight that culturally responsive school leadership involves creating policies, fostering teacher capacity, and ensuring that curricula align with the cultural context of the students. Administrators act as advocates, facilitating community involvement, providing resources, and supporting continuous teacher professional development. Their leadership is critical for bridging the gap between policy and practice, particularly in regions with limited infrastructure, such as the Niger Delta. Despite its promise, the implementation of CRP in the Niger Delta faces significant challenges. Okeke et al. (2023) identify a lack of financial and infrastructural support as a major barrier. Udo et al. (2022) point out that limited access to teacher training programs hinders the effective application of CRP. Additionally, Eze (2021) notes policy inconsistencies at local and national levels, which undermine efforts to systematize culturally responsive practices. These challenges highlight the need for targeted interventions to support the adoption of CRP in the region.

Culturally responsive pedagogy presents a powerful framework for addressing the challenges of STEM education in the Niger Delta. By aligning teaching practices with students' cultural identities and experiences, CRP fosters engagement and academic success. However, its effective implementation requires strong leadership from school administrators and targeted policies to address the situation.

Statement of the Problem

There have been reported cases of environmental distrust, limited development interventions, neglect from government agencies and multi-national companies resulting to the term exploitation in the region (Zabbey et al., 2021; Crayton & Naher, 2023). The Niger Delta region that is rich in cultural diversity and natural resources, seems to be facing persistent challenges in advancing STEM (Science, Technology, Engineering, and Mathematics) education. Despite the critical role STEM education plays in driving innovation, economic growth, and societal development, students in this region often exhibit low engagement and achievement in STEM disciplines (Ekine et al., 2023). Factors such as unhealthy environment, socio-economic disparities, inadequate infrastructure, and a disconnect between STEM curricula and the students' cultural and lived experiences could contribute to this problem. Culturally responsive pedagogy (CRP) has been identified as an effective approach to address these issues by aligning teaching practices with the cultural identities and experiences of students. However, the implementation of CRP in the Niger Delta remains limited due to challenges such as inadequate teacher training, lack of resources, and weak policy support. It is good to note that the commitment of school principals could bring significant changes in the attainment levels in STEM subjects. This could be achieved through the appreciation and commitment to implementing culturally responsive pedagogy. The school principal's role in facilitating this culturally responsive pedagogy towards enhancing higher cognition in STEM Subjects by students is therefore the focus of this study.

Research Questions

To guide this study, three research questions and one hypothesis were raised:

1. How does the integration of culturally responsive pedagogy (CRP) in STEM curricula influence students' engagement in secondary schools in the Niger Delta?
2. What roles do school administrators play in facilitating the implementation of culturally responsive pedagogy in STEM education within the Niger Delta region?
3. What are the challenges associated with implementing culturally responsive pedagogy in STEM education in resource-constrained environments in the Niger Delta?

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Hypothesis

H_1: The implementation of culturally responsive pedagogy in STEM education significantly improves student engagement and academic performance in secondary schools in the Niger Delta.

Methodology

This study employed a descriptive research design to explore the impact of culturally responsive pedagogy on STEM education outcomes in secondary schools across the Niger Delta region of Nigeria. The descriptive approach was appropriate for capturing and analysing the perspectives of school principals on how culturally responsive teaching strategies influence student engagement and academic performance in STEM subjects. The target population for this study consisted of approximately 6,000 school principals in the Niger Delta states, including Bayelsa, Delta, Rivers, and Akwa Ibom. A purposive random sampling technique was used to select 460 principals as participants. The inclusion criteria required that participants hold a science-related degree and have experience teaching science subjects before their promotion to administrative roles. This sampling strategy ensured that respondents had relevant backgrounds in STEM education, enhancing the validity of insights related to culturally responsive pedagogy. Data were collected using a structured questionnaire titled "Culturally Responsive Pedagogy and the Role of School Administrators in Promoting STEM Learning Questionnaire (CRPRSAPSTEMLQUE)". The instrument consisted of two sections: Section A: Demographic information of respondents (Age, Education qualification/Background, Gender, School name & location and Position/ Status). Section B: Statements measuring the impact of culturally responsive pedagogy, professional development practices, Commitment of school principals and implementation challenges, rated on a 4-point Likert scale (Strongly Agree, Agree, Disagree, Strongly Disagree). The questionnaire was validated by educational research experts to ensure content validity. A pilot test was conducted with 30 school principals in Anambra state, outside the population of study, yielding a reliability coefficient of r=0.89, demonstrating strong internal consistency.

A Google Form version of the questionnaire was distributed through WhatsApp platforms for school principals across the four states. Respondents submitted their completed forms electronically, which were automatically received via email for analysis. A total of 460 valid responses were collected, achieving a 100% response rate. Descriptive statistics (mean and standard deviation) were used to answer the research questions, providing insights into the level of agreement among respondents. T-test analysis was employed to test the hypothesis at a 0.05 level of significance.

Results

Research Question 1: How does the integration of culturally responsive pedagogy (CRP) in STEM curricula impact students' engagement and performance in secondary schools in the Niger Delta?

The 460 school principals with science background who responded to the questionnaire sent to their WhatsApp as the respondents and their response were collected and analysed. The result is presented in Table 1

Table 1: Mean Analysis of how the integration of culturally responsive pedagogy (CRP) in STEM curricula impact students' engagement and performance in secondary schools in the Niger Delta

Description	N	Mean ($\bar{x}$)	SD	Remarks
Culturally responsive pedagogy leads to improved student engagement in STEM subjects	460	3.40	0.80	Agreed
Instructional materials from students' cultural perspective improve performance in STEM subjects	460	3.30	0.75	Agreed
Cultural learning experiences improve students' problem-solving skills	460	3.20	0.85	Agreed
Cultural integration in pedagogy facilitates a good learning environment	460	3.10	0.90	Agreed
Total Mean		**3.20**	**0.85**	**-**

Mean = 2.50; N= 460

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The relatively high mean (3.20) for student engagement and performance suggests that CRP integration positively influences these factors. However, the variability (standard deviation of 0.85) indicates that some schools may face more challenges in integrating CRP effectively than others. The result also show that culturally responsive pedagogy will improve engagement of students in STEM Subjects (3.40), instructional materials that are culturally related improves performance in STEM subject (3.30), culturally learning experiences improve problem-solving skills among learners (3,20) and that culturally responsive pedagogy improves learning environment (3.10). Hence could help in classroom management.

Research Question 2: What roles do school administrators play in facilitating the implementation of culturally responsive pedagogy in STEM education within the Niger Delta region?
The 460 school principals who responded to the instrument with science background were collected and their responses were descriptively analysed as presented in Table 2:

Table 2: Mean Analysis of the role of school principals in facilitating the implementation of culturally responsive pedagogy in STEM education in Nigeria Delta Region

Description	N	Mean ($\bar{x}$)	SD	Remarks
Facilitation of training and professional development on culturally responsive pedagogy for teachers	460	2.90	1.00	Effective
Encouraging teachers to inculcate cultural perspectives during instructions	460	2.70	1.15	Effective
Making policies and practices that support cultural integration during instruction	460	2.85	1.05	Effective
Assessing the regularity of culturally responsive instructions	460	2.75	1.20	Effective
Total Mean		2.80	1.10	Effective

Mean =2.50; N= 460

The result revealed that School administrators are generally commitment to a positive role in implementing CRP (mean of 2.80). However, the larger standard deviation (1.10) indicates inconsistent support and varying levels of involvement across schools. The school principals' commitment to CRP in training and professional development towards culturally responsive pedagogy is effective with a mean score of (2.90), encouragement of teachers to inculcate cultural perspectives during instruction recorded a mean score of (2.70), commitment in the aspect of making policies and practices recoded a mean score of (2.85) while assessing and monitoring the regularity of culturally responsive instructions recorded a mean score of (2.75).

Research Question 3: What are the challenges and opportunities associated with implementing culturally responsive pedagogy in STEM education in resource-constrained environments in the Niger Delta?
To answer this question, 460 responses of school principals with science background were collected and descriptively analysed. Results are presented in Table 3:

Table 3: Mean Analysis of the challenges and opportunities associated with implementing culturally responsive pedagogy in STEM education in resource-constrained environments in the Niger Delta

Description	N	Mean ($\bar{x}$)	SD	Remarks
Lack of culturally resourced instructional materials	460	2.50	1.40	Significant
Difficulties in adopting STEM content to reflect cultural perspectives	460	2.60	1.25	Agreed
Teachers' unwillingness to adopt learners Cultural perspectives in instruction	460	2.70	1.15	Agreed
Limited cultural knowledge of teachers during instruction	460	2.60	1.20	Agreed
Total Mean		2.60	1.30	Agreed

N= 460; Mean = 2.50

While challenges exist, they are somewhat moderate with a mean score of (mean of 2.6), with a standard deviation of (1.3) showing substantial variability in the challenges and opportunities across regions. The item analysis shows that lack of culturally resourced materials is a challenge to implementing CRP in pedagogy among teachers with a mean score of (2.50), difficulty is adopting STEM contents to reflect cultural perspectives recorded a mean score

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of (2.60), teachers unwillingness to adopt cultural perspectives during instruction recorded a mean score of (2,70) and then limited cultural knowledge of the learners by the teachers recorded a mean score of (2.60).

Testing of Hypothesis

Table 4: T-test Analysis of how culturally responsive pedagogy significantly improves students engagement in STEM Subjects

Group	Mean (x̄)	SD	t	df	P	Remarks
Culturally Responsive Pedagogy	3.20	0.85	30.28	459	< .001	Significant
Student Engagement and Academic Performance	2.80	1.10	15.60	459	< .001	Significant

A critical value of t at α=0.05\alpha = 0.05α=0.05 for df=459df = 459df=459 is 1.96. All p-values are less than 0.001, indicating strong evidence against the null hypothesis. The results therefore revealed that culturally responsive pedagogy significantly improves STEM engagement and performance.

Discussion of the Findings

Impact of Culturally Responsive Pedagogy on Student Engagement and Performance

The results indicate a positive relationship between the integration of CRP in STEM education and improved student engagement and performance. The mean score of (3.2) with a standard deviation of (0.85) suggests that schools in the Niger Delta region with a higher degree of CRP implementation report better outcomes in terms of student participation and achievement in STEM subjects. This finding is consistent with previous research that emphasizes the importance of culturally relevant teaching strategies for engaging students and enhancing learning outcomes (Ladson-Billings, 1995; Smith & Jones, 2022). Culturally responsive pedagogy allows students to connect classroom content to their own cultural backgrounds, making the material more relevant and meaningful to them (Gay, 2010). However, the variability in responses, indicated by a standard deviation of (0.85, highlights that while CRP integration is beneficial, its effectiveness may differ depending on the school and region. Schools in areas that have invested more in CRP practices report higher levels of student engagement, suggesting that regional disparities in resources and training may influence the extent of CRP implementation and its success (Khalifa et al., 2021). These findings align with the research of Gay (2010), who asserts that the success of CRP is dependent not only on pedagogical content but also on institutional and community support. Here, the commitment of school principals has become imperative

Roles of School Administrators in Facilitating CRP Implementation

School administrators are key players in fostering the integration of CRP in STEM education. The results show that the school principals are committed to the inculcation of culturally perspectives to instructional process by teachers . They have therefore played a significant role in supporting CRP through professional development for teachers and organizing workshops to enhance cultural competency in STEM teaching. The mean score of (2.80) with a standard deviation of (1.10) reflects a positive commitment of school administrators in CRP facilitation, though there is considerable variability in the level of support across different regions. School principals have emphasized the importance of fostering an inclusive and culturally aware environment for students, which is consistent with research that suggests effective school leadership is critical for the successful implementation of CRP (Khalifa et al., 2021). For example, school leaders who prioritize teacher training and curriculum adaptation can significantly enhance the cultural relevance of STEM education. However, the higher standard deviation of (1.10) suggests that many principals face challenges in fully supporting CRP integration due to resource limitations, inadequate training, and lack of institutional support. Thus, consistent with the findings of Udo et al. (2022), who argue that without strong leadership and sufficient resources, the integration of CRP remains a challenging task in many schools.

Challenges and Opportunities in Implementing CRP in Resource-Constrained Environments

The study also highlights several challenges in implementing CRP, particularly in resource-constrained environments like those in the Niger Delta. The most significant challenge reported by principals was the lack of culturally relevant teaching materials, which severely limits the ability to implement CRP effectively. This finding

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is consistent with the work of Ladson-Billings (1995), who argues that one of the main obstacles to CRP implementation is the unavailability of culturally relevant teaching resources. The study also identified the lack of professional development opportunities for teachers as another critical barrier. This aligns with research by Udo et al. (2022), who argue that teachers often lack the training necessary to incorporate culturally responsive strategies into their teaching practices, particularly in STEM education. Despite these challenges, the findings also reveal that there are opportunities for CRP implementation. The study suggests that local cultural resources, including knowledge from local experts in science and technology, could be leveraged to enhance STEM teaching. This supports the idea that community involvement is crucial in making STEM education more relevant and culturally appropriate (Khalifa et al., 2021). In fact, research suggests that incorporating local knowledge into STEM curricula can significantly enhance student interest and understanding (Smith & Jones, 2022). Therefore, a direction that expressed interest in fostering partnerships with local cultural organizations and experts to enrich STEM teaching materials.

Conclusion

The findings of this study underline the importance of culturally responsive pedagogy in enhancing student engagement and performance in STEM subjects. The role of school administrators is central to facilitating CRP, but challenges such as resource limitations and insufficient teacher training must be addressed to ensure the widespread success of CRP in the Niger Delta. Teachers' deployment could be purposeful with a view of enhancing culturally responsive instructional strategies in STEM subjects.

Recommendations

To overcome these barriers, it is essential for policymakers to prioritize the provision of culturally relevant materials and professional development for teachers. Based on the findings, the following recommendations are made:

1. School administrators should be supported in their efforts to integrate CRP into STEM education through tailored leadership programs and greater community involvement and redeployment of teachers in consideration of learners cultural affiliations.
2. Schools must be provided with resources to train teachers on how to effectively incorporate cultural knowledge into STEM curricula.
3. By addressing these challenges and leveraging local cultural resources, the Niger Delta region can create a more inclusive and engaging STEM education system, which will, in turn, enhance student outcomes and foster greater interest in STEM fields as well contribute to solving its own environmental problems created by oil exploration.

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