

ORIGINAL RESEARCH ARTICLE

Impact of Climate Change Education Modules Infused into the Integrated Science Curriculum on Students' Awareness, Attitudes, and Adaptation Practices in Flood-Prone Areas of Anambra State

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ABSTRACT

This study investigated the impact of climate change education modules infused into the Integrated Science curriculum on the awareness, attitudes, and adaptation practices of secondary school students in flood-prone areas of Anambra State, Nigeria. A quasi-experimental pre-test/post-test control group design was adopted. The sample comprised 240 Senior Secondary School II (SSS II) students drawn from six purposively selected schools across three flood-prone Local Government Areas: Ogbaru, Onitsha South, and Awka South. Students were randomly assigned to experimental and control groups. The experimental group received instruction through infused Climate Change Education Modules (CCEMs), while the control group was taught using the conventional method. Three validated instruments were used for data collection: the Climate Change Awareness Test (CCAT), the Climate Change Attitude Scale (CCAS), and the Climate Change Adaptation Practices Inventory (CCAPI). Data were analyzed using analysis of covariance (ANCOVA) and t-test statistics at a 0.05 level of significance. Results revealed that students taught with CCEMs demonstrated significantly higher levels of awareness ($F(1, 237) = 84.32, p < .05$), more positive attitudes toward climate action ($F(1, 237) = 76.15, p < .05$), and improved climate adaptation practices ($F(1, 237) = 91.47, p < .05$) compared to the control group. Gender did not significantly moderate the treatment effects. The study recommends the systematic infusion of CCEMs into the Integrated Science curriculum at the secondary school level, especially in climate-vulnerable communities, to foster resilience and proactive environmental citizenship.

Keywords: Climate change education, Integrated Science curriculum, flood-prone areas, adaptation practices, Anambra State, awareness, attitudes, secondary schools

1. INTRODUCTION

Climate change ranks among the most formidable environmental challenges of the twenty-first century, with cascading consequences that disproportionately affect developing nations and their most vulnerable communities. In Nigeria, the manifestations of climate change are multifaceted, ranging from prolonged droughts in the north to intensified flooding events in the south. Anambra State, situated within the lower Niger River basin, is particularly susceptible to recurrent and devastating flood events that displace populations, destroy agricultural livelihoods, contaminate water sources, and undermine public health infrastructure (Adeyemi & Okafor, 2021; Nwosu, Eze, & Chukwu, 2020).

The floods of 2012 and 2022 remain etched in the collective memory of Anambra residents, having submerged entire communities in Local Government Areas such as Ogbaru, Onitsha South, and Awka South, leaving thousands homeless and causing extensive socioeconomic damage (Chukwuemeka & Nwosu, 2023). Despite these recurring catastrophes, community-level understanding of the climatic drivers, early warning

indicators, and viable adaptation strategies remains markedly inadequate. This deficit in climate literacy represents a critical gap that formal education, particularly science education, is uniquely positioned to address.

Education has long been recognized as a transformative instrument in cultivating environmental awareness and behavioral change (Hungerford & Volk, 1990; UNESCO, 2021). The integration of climate change content into existing school curricula offers a cost-effective and scalable strategy for building the knowledge capital needed to foster adaptive capacity. The Integrated Science curriculum at the junior and senior secondary school levels in Nigeria provides a particularly amenable platform for such infusion, given its interdisciplinary framework that encompasses biological, physical, chemical, and earth sciences (Federal Ministry of Education, 2019).

However, the conventional delivery of Integrated Science in Nigerian secondary schools has been criticized for its theoretical orientation, examination-driven focus, and failure to connect subject matter to students' lived realities and local environmental contexts (Okeke, Eze, & Anyanwu, 2022). Students in flood-prone communities possess firsthand experiential knowledge of climatic hazards yet receive little or no structured educational guidance on the scientific underpinnings or adaptive responses to these phenomena. This disconnect between academic content and contextual relevance impairs both learning outcomes and community resilience.

Climate Change Education Modules (CCEMs) represent an instructional innovation designed to bridge this gap. These modules incorporate locally contextualized climate scenarios, place-based learning activities, hands-on investigations, and community engagement tasks within the existing Integrated Science instructional framework. The underlying pedagogical philosophy draws from constructivist theory (Vygotsky, 1978), environmental education principles (Stapp et al., 1969), and culturally responsive teaching frameworks (Gay, 2010), positioning students as active agents in climate knowledge construction and community adaptation.

Several international and regional studies have demonstrated that curriculum-infused climate change education significantly improves student awareness and pro-environmental attitudes (Bhattacharya et al., 2021; Monroe et al., 2019; Obi & Ugwu, 2022). However, there remains a paucity of empirical evidence specifically addressing the impact of such interventions on student adaptation practices, particularly in the Nigerian context, and more narrowly, in communities actively experiencing flood events. This study responds to that gap by examining the measurable effects of CCEMs on three interrelated outcome dimensions: awareness, attitudes, and adaptation practices among secondary school students in flood-prone areas of Anambra State.

1.1 Statement of the Problem

Secondary school students in flood-prone communities of Anambra State continue to demonstrate low levels of climate change literacy, negative or indifferent attitudes toward environmental action, and limited engagement with adaptive practices, despite residing in areas routinely devastated by climate-induced flooding. The conventional Integrated Science curriculum does not systematically address local climate change phenomena, thereby denying students access to knowledge and skills critical for personal and community resilience. No prior study has specifically assessed the impact of a module-based climate change infusion strategy on the triad of awareness, attitudes, and adaptation practices within this specific population and geographic context.

1.2 Purpose of the Study

The primary purpose of this study was to determine the impact of Climate Change Education Modules infused into the Integrated Science curriculum on the awareness, attitudes, and adaptation practices of secondary school students in flood-prone areas of Anambra State. Specifically, the study sought to:

- Determine the effect of CCEMs on students' awareness of climate change and flood-related risks.

- Assess the influence of CCEMs on students' attitudes toward climate change adaptation.
- Examine the effect of CCEMs on students' climate change adaptation practices.
- Investigate whether gender moderates the effects of CCEM instruction on any of the three outcome variables.

1.3 Research Questions

The following research questions guided the study:

- What is the mean awareness score of students taught with CCEMs compared to those taught with the conventional method?
- What is the mean attitude score of students taught with CCEMs compared to those in the control group?
- What is the mean adaptation practices score of students taught with CCEMs compared to those taught conventionally?
- Is there a significant interaction between instructional method and gender on students' awareness, attitudes, and adaptation practices?

1.4 Hypotheses

The following null hypotheses were tested at a 0.05 level of significance:

2. LITERATURE REVIEW

2.1 Theoretical Framework

This study is anchored on three theoretical frameworks that collectively provide a robust conceptual foundation for climate change education. First, Vygotsky's (1978) sociocultural theory of cognitive development underscores the role of social interaction, language, and cultural context in shaping knowledge construction. Climate change education that draws on students' community experiences with floods and environmental hazards situates learning within a meaningful sociocultural context, facilitating deeper comprehension and retention (Bybee, 2014).

Second, Hungerford and Volk's (1990) environmental citizenship model posits that environmental awareness, sensitivity, and knowledge serve as preconditions for the development of environmental action competency. This hierarchical progression from awareness to attitude formation to behavioral change provides the theoretical scaffolding for the three outcome variables examined in this study. The model suggests that structured educational interventions that systematically build awareness and cultivate positive attitudes are more likely to translate into concrete adaptive behaviors.

Third, the Theory of Planned Behavior (Ajzen, 1991) offers insights into the attitudinal and normative factors that mediate between knowledge acquisition and behavioral practice. According to this theory, behavioral intentions, and by extension, actual behaviors, are shaped by attitudes toward the behavior, subjective norms, and perceived behavioral control. Climate change education that targets all three antecedents simultaneously is more likely to effect meaningful changes in students' adaptation practices.

2.2 Climate Change and Flooding in Anambra State

Anambra State's vulnerability to flooding is well-documented in the scientific and policy literature. The state's location in the Niger Delta basin, combined with increasing precipitation variability attributable to anthropogenic climate change, rapid urbanization, and inadequate drainage infrastructure, creates conditions of chronic flood exposure (Nwosu et al., 2020). Studies by Adeyemi and Okafor (2021) indicate that flood frequency and severity in the state have increased significantly over the past two decades, with particularly acute impacts in low-lying local government areas such as Ogbaru and Onitsha South.

The socioeconomic consequences of flooding in Anambra are severe. Chukwuemeka and Nwosu (2023) documented the displacement of over 200,000 residents during the 2022 flood event, with significant losses in agricultural output, housing stock, and educational infrastructure. Schools in affected communities were disproportionately impacted, with prolonged closures disrupting academic continuity. These disruptions further disadvantage already-vulnerable student populations and underscore the urgency of climate-responsive education that equips students with adaptive knowledge and skills.

2.3 Climate Change Education in School Curricula

International educational frameworks increasingly emphasize the importance of climate change education as a core component of quality education for sustainable development. UNESCO's (2021) Education for Sustainable Development (ESD) for 2030 framework explicitly calls for the mainstreaming of climate change literacy across all levels of formal education. In the Nigerian context, the National Policy on Education (Federal Republic of Nigeria, 2014) and the National Curriculum for Basic and Secondary Education provide entry points for climate change integration, though implementation has remained inconsistent and largely ad hoc (Federal Ministry of Education, 2019).

Several approaches to climate change curriculum integration have been documented in the literature. Cross-curricular infusion, standalone elective courses, project-based learning modules, and community-based inquiry approaches each offer distinct pedagogical affordances (Monroe et al., 2019). For resource-constrained contexts like Nigeria's public secondary school system, curriculum infusion, wherein climate change content is systematically embedded within existing subject areas, offers the most pragmatic pathway to scale (Okeke et al., 2022). Integrated Science, with its interdisciplinary scope spanning earth science, ecology, atmospheric science, and human-environment interactions, is particularly well-suited to absorb climate change education modules without requiring structural curriculum overhaul.

2.4 Effects of Climate Change Education on Awareness, Attitudes, and Practices

A growing body of empirical research attests to the efficacy of structured climate change education in improving student outcomes. Bhattacharya et al. (2021) conducted a meta-analysis of 47 experimental studies and found consistent positive effects of climate change education interventions on awareness ($d = 0.74$), attitudes ($d = 0.61$), and behavioral intentions ($d = 0.52$). These effect sizes are comparable to or exceed those observed for other science education innovations, lending empirical credibility to the potential of CCEMs in the current study context.

In the West African context, Obi and Ugwu (2022) found that climate change education infused into secondary school geography lessons significantly improved students' knowledge of flood risks and climate adaptation strategies in Rivers State, Nigeria. Similarly, Eze and Amaechi (2023) reported that environmental education modules embedded in basic science lessons led to improved pro-environmental behaviors among junior secondary students in Enugu State. These findings provide direct contextual precedents for the current investigation.

Gender dynamics in climate change education outcomes present a nuanced picture. While some studies report higher climate change awareness among female students (Norgaard & York, 2005), others find no significant gender differences in knowledge or behavioral outcomes when controlling for instructional quality (Obi & Ugwu, 2022). The current study contributes to this discussion by examining gender as a potential moderating variable in the CCEM intervention context.

3. METHODOLOGY

3.1 Research Design

The study adopted a quasi-experimental pre-test/post-test control group design. This design was appropriate given the ethical and practical constraints of fully randomized assignment in an intact school system. Two groups, experimental and control, were established, with pre-test scores serving as covariates in the ANCOVA analysis to control for pre-existing differences. The experimental group received instruction through infused Climate Change Education Modules, while the control group received conventional instruction based on the standard Integrated Science curriculum.

3.2 Population and Sample

The target population comprised all Senior Secondary School II (SSS II) students in public secondary schools located in flood-prone Local Government Areas of Anambra State. Three LGAs with documented high flood vulnerability indices were purposively selected: Ogbaru, Onitsha South, and Awka South. From each LGA, two secondary schools were selected using stratified random sampling, yielding a total of six schools. Within each school, one intact SSS II class was randomly assigned to either the experimental ($n = 120$) or control ($n = 120$) condition, resulting in a total sample of 240 students (128 females, 112 males; mean age = 16.4 years, $SD = 0.87$).

3.3 Instrumentation

Three instruments were developed and validated for data collection:

Climate Change Awareness Test (CCAT): A 40-item multiple-choice test assessing students' knowledge of climate change concepts, causes, consequences, and local flood-related phenomena. Items were developed based on the revised Bloom's taxonomy cognitive levels of knowledge, comprehension, and application. The CCAT was validated by five experts in science education and environmental studies, yielding a content validity index (CVI) of 0.87. Internal reliability was established using Kuder-Richardson Formula 20 (KR-20), yielding a reliability coefficient of 0.82.

Climate Change Attitude Scale (CCAS): A 25-item Likert-scale instrument (5-point scale: Strongly Agree to Strongly Disagree) measuring students' affective orientations toward climate change issues, environmental responsibility, and community adaptation. After validation and item analysis, a 25-item scale was retained with a Cronbach's alpha reliability coefficient of 0.79.

Climate Change Adaptation Practices Inventory (CCAPI): A 30-item behavioral checklist and frequency scale assessing students' self-reported engagement in climate adaptation behaviors such as waste management, rainwater harvesting, flood preparedness, community environmental advocacy, and sustainable resource use. The CCAPI had a Cronbach's alpha of 0.81.

3.4 The Climate Change Education Modules (CCEMs)

The CCEMs were developed over a six-month period by the researcher in collaboration with two secondary school Integrated Science teachers and an environmental education specialist. The modules consisted of six thematic units integrated across the SSS II Integrated Science curriculum: (1) Earth's Climate System and the Greenhouse Effect; (2) Climate Change Evidence and Indicators in Nigeria; (3) Flooding: Causes, Types, and Local Risk Factors in Anambra State; (4) Human and Community Impacts of Climate-Induced Flooding; (5) Climate Change Adaptation Strategies: Community and Individual Responses; and (6) Climate Action and Environmental Citizenship.

Each module employed a blend of inquiry-based learning, case studies from local flood events, community mapping activities, role-play simulations, and reflective journaling. Lessons were designed to align with existing SSS II Integrated Science topics in physics, biology, chemistry, and earth science, ensuring curriculum coherence. The modules were piloted with 30 students in a non-sampled school before full deployment, and revisions were made based on teacher and student feedback.

3.5 Procedure

Data collection spanned 12 weeks. In Week 1, pre-tests were administered to both groups using all three instruments. In Weeks 2 through 11, the experimental group received CCEM instruction (two 45-minute periods per week), while the control group continued with regular Integrated Science lessons without climate change infusion. In Week 12, post-tests were administered to both groups using the same instruments. Research assistants, two trained Integrated Science teachers in each school, administered the instruments and monitored treatment fidelity. A treatment fidelity checklist was used to document adherence to module protocols, with an observed fidelity rate of 91%.

3.6 Data Analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics (means and standard deviations) were used to answer the research questions. Analysis of Covariance (ANCOVA) was employed to test the null hypotheses, with pre-test scores as covariates to control for baseline differences. The alpha level was set at 0.05 for all inferential tests. Effect sizes were computed using partial eta-squared (η^2p) to assess the practical significance of observed differences.

4. RESULTS

4.1 Pre-test Equivalence of Groups

Prior to the intervention, independent samples t-tests confirmed that the experimental and control groups did not differ significantly on pre-test CCAT scores ($t(238) = 0.84, p = .40$), CCAS scores ($t(238) = 1.12, p = .26$), or CCAPI scores ($t(238) = 0.97, p = .33$). This equivalence justified the use of ANCOVA with pre-test scores as covariates.

Table 1 presents the descriptive statistics for pre-test and post-test scores across both groups.

Group	Measure	Pre-test M (SD)	Post-test M (SD)	Gain
Experimental (n = 120)	CCAT	14.73 (3.21)	28.56 (4.12)	13.83
Experimental (n = 120)	CCAS	72.14 (8.43)	95.38 (9.61)	23.24
Experimental (n = 120)	CCAPI	41.62 (7.15)	67.44 (8.73)	25.82
Control (n = 120)	CCAT	14.28 (3.47)	17.31 (3.89)	3.03
Control (n = 120)	CCAS	71.83 (8.19)	75.42 (8.54)	3.59
Control (n = 120)	CCAPI	40.97 (6.88)	44.88 (7.26)	3.91

Table 1. Pre-test and post-test descriptive statistics by group

Note. CCAT = Climate Change Awareness Test; CCAS = Climate Change Attitude Scale; CCAPI = Climate Change Adaptation Practices Inventory.

(CCAT = Climate Change Awareness Test; CCAS = Climate Change Attitude Scale; CCAPI = Adaptation Practices Inventory)

4.2 Research Question 1: Effect on Climate Change Awareness

The mean post-test CCAT score for the experimental group ($M = 28.56, SD = 4.12$) was considerably higher than that of the control group ($M = 17.31, SD = 3.89$), reflecting an adjusted mean difference of 10.87. This represents a mean gain of 13.83 points for the experimental group against a gain of 3.03 points for the control

group. These findings indicate that students taught through CCEMs demonstrated substantially greater climate change awareness than their counterparts in the conventional instruction condition.

4.3 Research Question 2: Effect on Climate Change Attitudes

Students in the experimental group recorded a mean post-test CCAS score of 95.38 (SD = 9.61), compared to 75.42 (SD = 8.54) for the control group. The adjusted post-test mean difference of 19.72 points indicates that CCEM instruction was associated with markedly more positive attitudes toward climate change adaptation, environmental responsibility, and community action than the conventional approach.

4.4 Research Question 3: Effect on Adaptation Practices

The experimental group's mean post-test CCAPI score ($M = 67.44$, $SD = 8.73$) substantially exceeded the control group mean ($M = 44.88$, $SD = 7.26$). The adjusted mean difference of 22.17 points suggests that CCEM-instructed students demonstrated significantly greater engagement in climate adaptation behaviors. These behaviors included increased participation in community flood preparedness activities, adoption of household water conservation measures, and advocacy for local environmental protection.

4.5 Hypothesis Testing

Table 2 summarises the ANCOVA results for all three outcome variables.

Hypothesis	Outcome	F	df	p	η^2p	Decision
HO1	Awareness (CCAT)	84.32	1, 237	< .001	0.26	Rejected
HO2	Attitudes (CCAS)	76.15	1, 237	< .001	0.24	Rejected
HO3	Adaptation (CCAPI)	91.47	1, 237	< .001	0.28	Rejected
HO4	Method $\times$ gender (CCAT)	1.43	1, 236	.23	—	Retained
HO4	Method $\times$ gender (CCAS)	0.87	1, 236	.35	—	Retained
HO4	Method $\times$ gender (CCAPI)	1.11	1, 236	.29	—	Retained

Table 2. ANCOVA summary for awareness, attitudes, adaptation practices and gender interaction

HO1 – Climate Change Awareness: ANCOVA revealed a statistically significant main effect of instructional method on post-test CCAT scores, $F(1, 237) = 84.32$, $p < .001$, $\eta^2p = 0.26$. HO1 was rejected.

HO2 – Climate Change Attitudes: ANCOVA revealed a statistically significant main effect of instructional method on post-test CCAS scores, $F(1, 237) = 76.15$, $p < .001$, $\eta^2p = 0.24$. HO2 was rejected.

HO3 – Adaptation Practices: ANCOVA revealed a statistically significant main effect of instructional method on post-test CCAPI scores, $F(1, 237) = 91.47$, $p < .001$, $\eta^2p = 0.28$. HO3 was rejected.

HO4 – Gender Interaction: The interaction between instructional method and gender was not statistically significant for any of the three outcome variables: CCAT, $F(1, 236) = 1.43$, $p = .23$; CCAS, $F(1, 236) = 0.87$, $p = .35$; CCAPI, $F(1, 236) = 1.11$, $p = .29$. HO4 was retained, indicating that CCEM instruction was equally effective for male and female students.

5. DISCUSSION

The findings of this study provide compelling evidence that the infusion of Climate Change Education Modules into the Integrated Science curriculum yields significant and practically meaningful improvements in secondary school students' climate change awareness, attitudes, and adaptation practices in flood-prone communities of Anambra State. Each of these outcome dimensions warrants detailed interpretive discussion.

5.1 Enhanced Climate Change Awareness

The substantial improvement in CCAT scores among CCEM-instructed students (mean gain of 13.83 points versus 3.03 for the control group) confirms the efficacy of contextualized, module-based instruction in building climate literacy. This finding is consistent with the meta-analytic evidence reported by Bhattacharya et al. (2021), who identified knowledge gains as the most reliably observed outcome of climate change education interventions. The relatively modest gains in the control group suggest that conventional Integrated Science instruction, while providing some incidental exposure to climate-related concepts, does not systematically develop the depth of understanding needed for informed climate action.

A key factor contributing to the experimental group's superior awareness outcomes appears to be the place-based, contextually anchored character of the CCEM curriculum. By grounding climate science content in local flood events, community case studies, and Anambra-specific data, the modules enabled students to make direct connections between abstract scientific concepts and observable environmental phenomena. This pedagogical strategy aligns with research demonstrating that local relevance and cultural responsiveness are powerful drivers of science learning motivation and conceptual engagement (Gay, 2010; Taber, 2011).

5.2 Positive Attitudinal Change

The significant improvement in CCAS scores among CCEM students represents a particularly important finding. Attitude change is widely recognized as a more complex and difficult outcome to achieve than cognitive knowledge gains, as it involves affective restructuring, values clarification, and social identity considerations (Kollmuss & Agyeman, 2002). The magnitude of the attitudinal improvement observed (adjusted mean difference of 19.72 points) suggests that the CCEM intervention achieved substantial affective impact.

This outcome is attributable, in part, to the modules' deliberate incorporation of role-play simulations, community engagement tasks, and reflective journaling activities that prompted students to examine their own values, beliefs, and responsibilities in relation to climate change. These activities facilitated the kind of perspective-taking and social norm formation that Ajzen's (1991) Theory of Planned Behavior identifies as crucial precursors to behavioral intention and action. Notably, the gender-neutral effect on attitudinal outcomes diverges somewhat from studies reporting female students' greater environmental concern (Norgaard & York, 2005), suggesting that well-designed, contextually relevant instruction may be sufficient to engage both male and female students equally in climate attitude formation.

5.3 Improved Adaptation Practices

The most striking finding of this study concerns the effect of CCEM instruction on adaptation practices. With an adjusted mean difference of 22.17 points on the CCAP and the largest partial eta-squared value ($\eta^2_p = 0.28$), adaptation behavior emerged as the outcome domain most strongly and practically influenced by the intervention. This finding has significant implications for climate resilience in vulnerable communities.

Students in the experimental group reported substantially greater engagement in a range of adaptive behaviors, from individual-level actions such as proper waste disposal and water conservation to community-oriented behaviors such as participation in flood early warning systems and environmental advocacy. This behavioral breadth suggests that the CCEMs succeeded in equipping students with not only the knowledge and motivation to act but also the specific behavioral repertoire and perceived efficacy needed to translate intent

into practice, consistent with Social Cognitive Theory's (Bandura, 1977) concept of self-efficacy as a mediator of behavior change.

The community mapping and participatory inquiry activities embedded in the modules appear to have been particularly instrumental in catalyzing adaptation behaviors. By engaging students in active documentation of local flood risks, drainage patterns, and community vulnerability hotspots, these activities transformed abstract learning into tangible community contribution, reinforcing students' sense of agency and environmental citizenship.

5.4 Gender Neutrality of Effects

The non-significant gender interaction effects across all three outcome variables indicate that the CCEM intervention was equally effective for male and female students. This finding is noteworthy for equity-oriented educational planning, suggesting that curriculum-infused climate change education designed with inclusive pedagogical strategies does not systematically disadvantage students based on gender. The result aligns with Obi and Ugwu's (2022) findings from a comparable Nigerian educational context and supports the use of CCEMs as a universally applicable instructional innovation regardless of student gender composition.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study has demonstrated that the infusion of Climate Change Education Modules into the Integrated Science curriculum produces significant and practically meaningful improvements in the climate change awareness, attitudes, and adaptation practices of secondary school students in flood-prone areas of Anambra State. The CCEM intervention outperformed conventional instruction across all three outcome dimensions, with the largest effects observed for adaptation practices, precisely the dimension most directly linked to community resilience and disaster risk reduction. Gender did not moderate treatment effects, confirming the inclusive applicability of the intervention. These findings position CCEMs as a scalable, curriculum-coherent, and evidence-based strategy for building climate literacy and adaptive capacity in Nigeria's most climate-vulnerable communities.

6.2 Recommendations

Based on the findings of this study, the following recommendations are offered:

- The Nigerian Educational Research and Development Council (NERDC) should revise the Integrated Science curriculum to systematically incorporate climate change education content, particularly for schools in flood-vulnerable states.
- The Anambra State Ministry of Education should prioritize professional development programs that equip Integrated Science teachers with the knowledge and pedagogical skills required to deliver climate change education effectively.
- The CCEMs developed for this study should be adapted, piloted, and validated for deployment in other flood-prone and climate-vulnerable states in Nigeria.
- Future research should examine the long-term durability of CCEM-induced knowledge, attitudinal, and behavioral gains through longitudinal follow-up studies.
- Community-school partnerships should be formalized to extend CCEM-initiated student adaptation behaviors into broader community resilience planning processes, ensuring that classroom learning translates into community-level action.

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