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CLASSROOM CULTURE, COLLABORATION AND PARTICIPATION IN GREEN CHEMISTRY PROJECTS: AN ETHNOGRAPHIC STUDY IN SECONDARY SCHOOLS IN BAYELSA STATE, NIGERIA

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Abstract
This study examined classroom culture, collaboration and participation in green chemistry projects in secondary schools in Bayelsa State, Nigeria. The study adopted a qualitative research approach using an ethnographic design to explore classroom practices, collaborative interactions and students' experiences of participation in green chemistry activities. Seven participants, comprising two chemistry teachers and five students from two secondary schools, were purposively selected based on their involvement in green chemistry projects. Data were obtained through semi-structured interview responses organised around the three research objectives and analysed using reflexive thematic analysis. The findings revealed that classroom culture was predominantly teacher-directed, characterised by established safety expectations and restricted opportunities for independent student decision-making. Collaboration occurred through shared problem-solving, discussion of experimental observations and collective task execution; however, unequal responsibility allocation, dominant group members and limited instructional resources constrained effective cooperation. Students' participation varied according to confidence, instructional clarity, access to practical activities and the relevance of projects to familiar environmental problems. Teacher interventions, including role rotation, individual encouragement and task redistribution, were identified as practices that supported more inclusive participation. The study concludes that integrating green chemistry projects into secondary school instruction does not automatically guarantee meaningful collaboration and participation, as classroom practices and social interactions substantially influence students' learning experiences. It recommends that chemistry teachers foster supportive classroom cultures, establish equitable collaborative arrangements and provide opportunities for all students to participate actively in green chemistry projects. The study contributes to understanding the social dimensions of sustainability-oriented chemistry education in environmentally vulnerable educational contexts.

Keywords: Classroom Culture; Collaboration; Student Participation; Green Chemistry Projects; Ethnographic Study; Secondary Schools; Bayelsa State.

Introduction
The growing concern over environmental degradation and sustainability has intensified the need to integrate environmentally responsible practices into science education. Green chemistry provides a framework for reducing hazardous substances, preventing pollution and promoting sustainable chemical processes. Anastas and Eghbali (2010) emphasise that green chemistry prioritises the design of chemical products and processes that minimise environmental harm. However, translating these principles into secondary school education requires more than curriculum inclusion; it demands learning environments that encourage practical engagement and meaningful scientific inquiry. Koulougliotis et al. (2024) identified inquiry-based and problem-based approaches as important strategies in green chemistry education. Nevertheless, their emphasis on instructional approaches and learning outcomes leaves questions about the social practices shaping students' experiences of green chemistry projects.

Classroom culture is particularly significant because it shapes the expectations, interactions and practices through which learning occurs. Lave and Wenger (1991) conceptualise learning as a

socially situated process, suggesting that students' educational experiences are influenced by their involvement in shared classroom activities. Although supportive classroom cultures may encourage inquiry and engagement, established teacher-centred practices may restrict students' opportunities to contribute meaningfully. Consequently, examining classroom culture is essential for understanding how green chemistry projects are experienced within secondary schools.

Collaboration represents another important dimension of green chemistry projects, particularly where students undertake collective investigations and environmental problem-solving activities. Johnson and Johnson (2009) demonstrate that cooperative learning can enhance reasoning, achievement and interpersonal relationships. However, organising students into groups does not necessarily guarantee genuine collaboration, as unequal contributions and limited interaction may undermine collective learning. Similarly, participation extends beyond attendance or task completion to students' meaningful involvement in learning activities. Lave and Wenger (1991) emphasise participation as fundamental to knowledge development, highlighting the need to examine students' actual engagement rather than assuming that project-based learning automatically promotes active involvement.

Within Nigeria, emerging studies have examined green chemistry awareness and instructional preparedness. Okunuga and Adeoye (2025) investigated secondary school students' awareness and knowledge of green chemistry, while Owoyemi and Akinde (2026) identified challenges relating to teachers' competencies and curriculum integration. Although these studies contribute valuable insights, their emphasis on awareness and teacher preparedness provides limited understanding of classroom interactions and students' experiences during green chemistry projects. This limitation is particularly relevant to Bayelsa State, where petroleum-related environmental degradation presents opportunities for connecting chemistry education with local environmental challenges (Bayelsa State Oil and Environmental Commission, 2023).

Despite increasing scholarly interest in green chemistry education, limited attention within the reviewed literature has been directed towards the everyday classroom practices through which students experience green chemistry projects, particularly in Bayelsa State. An ethnographic approach offers opportunities to investigate these practices within their natural educational contexts. Therefore, this study examines classroom culture, explores students' collaboration and investigates students' participation in green chemistry projects in secondary schools in Bayelsa State, Nigeria. The study seeks to provide contextual insights that may inform culturally responsive and participatory approaches to green chemistry education.

Aim and Objectives of the Study

The aim of this study is to explore how classroom culture shapes students' collaboration and participation in green chemistry projects in secondary schools in Bayelsa State, Nigeria, using an ethnographic approach.

1. Examine the classroom culture surrounding green chemistry projects in secondary schools in Bayelsa State, Nigeria.
2. Explore students' collaboration in green chemistry projects in secondary schools in Bayelsa State, Nigeria.
3. Investigate students' participation in green chemistry projects in secondary schools in Bayelsa State, Nigeria.

Research Questions

The following research questions are formulated to guide the study:

1. How does classroom culture influence students' engagement in green chemistry projects in secondary schools in Bayelsa State?
2. What patterns and practices of collaboration exist among students and teachers during green chemistry projects in secondary schools in Bayelsa State?

3. How do classroom norms, social interactions, and teacher–student relationships shape students' participation in green chemistry projects in secondary schools in Bayelsa State?

The study adopted a qualitative research approach using an ethnographic research design to examine classroom culture, collaboration and participation in green chemistry projects in secondary schools in Bayelsa State, Nigeria. The ethnographic approach was considered appropriate because it provided an opportunity to explore students' experiences, social interactions and classroom practices within their natural educational settings. Hammersley and Atkinson (2019) emphasised that ethnographic research involves understanding the meanings and practices that characterise the everyday experiences of individuals within particular social contexts. The study focused on seven (7) secondary school students who participated in green chemistry projects in Bayelsa State. The participants were selected purposively based on their involvement in green chemistry-related classroom activities and their ability to provide relevant accounts of their experiences. The small sample was consistent with the qualitative orientation of the study, which prioritised detailed contextual understanding rather than statistical generalisation.

Data were collected through semi-structured interviews, supported by the ethnographic orientation of the study. The interview protocol consisted of nine open-ended questions organised around the three research objectives: classroom culture, students' collaboration and students' participation in green chemistry projects. Each objective was addressed through three principal questions, with additional probing questions used to obtain clarification and detailed accounts of participants' experiences. The interviews explored students' perceptions of classroom routines, their experiences of working with classmates and their involvement in green chemistry project activities. The semi-structured format provided opportunities for participants to describe experiences in their own words while allowing flexibility to explore issues emerging during the interviews. The interviews were intended to generate detailed accounts of the social and instructional practices surrounding green chemistry projects.

Data analysis was guided by Braun and Clarke's (2022) six-phase reflexive thematic analysis. The process involved familiarisation with the interview data, generation of initial codes, construction of preliminary themes, review and refinement of themes, definition and naming of themes, and production of the analytical report. The analysis was organised around the three research objectives while remaining open to unexpected patterns emerging from participants' accounts. Particular attention was given to the classroom practices students described, their experiences of collaboration and the ways they participated in green chemistry projects. Trustworthiness was considered using Lincoln and Guba's (1985) criteria of credibility, transferability, dependability and confirmability. These criteria informed the interpretation and presentation of participants' accounts, with attention to contextual detail, transparency and reflexivity. Ethical considerations included voluntary participation, confidentiality, protection of participants' identities and respect for their rights. As the participants were secondary school students, parental or guardian consent and students' assent were recognised as important safeguards. Pseudonyms were used in reporting participants' accounts to protect their identities.

Results

The findings are presented according to the three research questions guiding the study: classroom culture, students' collaboration and students' participation in green chemistry projects in secondary schools in Bayelsa State, Nigeria. The analysis followed a thematic approach, identifying recurring patterns, differences and contrasting experiences across participants' accounts. Particular attention was given to how classroom practices shaped the organisation of green chemistry activities, how students worked together and how opportunities for participation were distributed.

Research Question 1: What classroom culture characterised green chemistry projects in secondary schools in Bayelsa State?

Analysis of the participants' accounts revealed three interconnected themes: teacher-directed classroom practices, safety-oriented learning expectations and conditional openness to students' ideas.

Table 1: Themes emerging from classroom culture

Theme	Key findings	Supporting participants
Teacher-directed classroom practices	Teachers established procedures, controlled materials and supervised experimental decisions.	P01, P02, P03, P06, P07
Safety-oriented learning expectations	Classroom routines emphasised labelling, careful handling, small quantities and waste prevention.	P01–P07
Conditional openness to students' ideas	Suggestions were sometimes encouraged, but time constraints, peer reactions and teacher authority restricted independent contributions.	P01, P02, P03, P04, P05, P07

Teacher-directed classroom practices

The findings indicated that classroom culture was predominantly structured around teacher-directed practical activities, although opportunities existed for students to engage in discussion and investigation. Teachers generally introduced environmental problems, demonstrated procedures and established the boundaries within which students conducted their projects. Teacher A (P01) explained:

I usually introduce an environmental problem before the practical work.

Similarly, Teacher B (P02) acknowledged the restrictive character of classroom practices:

Our lessons are usually more directed than I would like.

Students' accounts reinforced this pattern. Student A (P03) explained that most experimental steps were already written on the board, while Student D (P06) described a classroom in which students followed predetermined procedures and shared available materials. These findings suggested that teachers retained considerable control over project implementation, even when activities were organised around student groups.

A notable difference emerged between the two schools. In School A, students described some opportunities to propose procedural adjustments, whereas School B participants placed greater emphasis on following written instructions and managing limited equipment. Nevertheless, neither setting demonstrated unrestricted student autonomy. The evidence therefore suggested a classroom culture combining teacher supervision with selective opportunities for student initiative.

Safety-oriented learning expectations

A prominent feature of classroom culture was the emphasis on safety, careful material handling and waste prevention. Participants consistently described expectations relating to labelling containers, avoiding unnecessary mixing and using small quantities of materials.

Teacher A (P01) explained:

We also discuss using small quantities and reducing waste.

Student C (P05) similarly described classroom expectations involving careful disposal and the need to avoid assuming that all substances could be discarded through the drain.

However, the findings exposed a distinction between following safety instructions and understanding their environmental significance. Teacher B (P02) observed that students were often more familiar with safety rules than the environmental reasoning underlying them. Student D (P06) described how a teacher's explanation helped clarify the relationship between smaller experimental quantities and reduced waste.

Thus, classroom culture supported environmentally responsible routines, but students' understanding of the reasons for these practices was not always immediate or independently developed.

Conditional openness to students' ideas

The findings further revealed that opportunities for questioning and contributing ideas existed but were unevenly experienced. Student A (P03) recalled suggesting the use of white paper to improve the visibility of colour changes during a plant-indicator experiment. The teacher permitted the group to test the suggestion, which increased the student's confidence.

By contrast, Student B (P04) described reluctance to ask questions publicly:

I sometimes keep my question to myself because some classmates laugh when a person uses the wrong word.

Time constraints also limited the consideration of students' suggestions. Teacher A (P01) acknowledged occasionally providing answers too quickly, while Student E (P07) described a proposed waste-comparison activity that could not be completed because of limited time.

These accounts indicated that classroom culture was neither entirely restrictive nor consistently participatory. Instead, students' opportunities to contribute were shaped by teacher responses, peer behaviour and the practical demands of classroom activities.

Research Question 2: How did students collaborate during green chemistry projects in secondary schools in Bayelsa State?

Three major themes emerged concerning collaboration: shared problem-solving, unequal distribution of group responsibilities and the influence of peer relationships and resource limitations.

Table 2: Themes emerging from students' collaboration

Theme	Key findings	Supporting participants
Shared problem-solving	Students compared observations, discussed disagreements and collectively addressed experimental difficulties.	P01, P02, P03, P05, P06, P07
Unequal distribution of responsibilities	Confident or faster students frequently controlled practical tasks, while others concentrated on recording and cleaning.	P01–P07
Peer relationships and resource limitations	Friendship groups, leadership practices and limited materials influenced collaborative interactions.	P01, P02, P04, P06, P07

Shared problem-solving during project activities

The findings demonstrated that green chemistry projects provided opportunities for collaborative investigation, particularly when students encountered practical difficulties requiring discussion and collective decisions. Participants described situations involving inconsistent experimental results, labelling problems and disagreements over scientific observations.

Student A (P03) recalled a disagreement concerning the colour of a sample:

We recorded that the shade was uncertain instead of forcing everyone to agree immediately.

This account illustrated a collaborative process in which students reconsidered their observations and acknowledged uncertainty rather than imposing an immediate consensus.

Similarly, Student C (P05) described comparing experimental quantities after discovering that the group's results differed from those of another group. Student E (P07) explained how group members discussed whether reducing the quantity of a material necessarily represented the most appropriate experimental decision.

These accounts indicated that collaboration sometimes extended beyond the physical sharing of tasks to include discussion, evaluation and the reconsideration of scientific conclusions. However, the extent of this collaboration differed across groups and activities.

Unequal distribution of group responsibilities

Despite evidence of cooperation, participants consistently described inequalities in the allocation of responsibilities. Practical activities were frequently controlled by confident or faster students, while less assertive group members undertook recording, labelling or cleaning tasks.

Teacher A (P01) acknowledged this challenge:

Being placed in the same group does not mean everybody contributes equally.

Student A (P03) similarly reported that the same students frequently selected practical tasks first, leaving the participant responsible for recording observations. Student B (P04) described accepting labelling and cleaning duties without feeling sufficiently confident to request a measuring task.

Interestingly, Student C (P05), who frequently coordinated group activities, acknowledged contributing to this imbalance:

I have noticed that I sometimes do a task myself instead of giving someone time to learn it.

This contrasting perspective indicated that unequal collaboration was not always the result of deliberate exclusion. It could also emerge from an emphasis on completing project activities efficiently.

Teacher-directed role rotation appeared to provide some opportunities for redistributing responsibilities. Nevertheless, accounts from both schools suggested that rotation was not consistently implemented. Consequently, group membership did not necessarily ensure equal opportunities to develop practical experience.

Peer relationships and resource limitations

The findings also revealed that collaboration was influenced by friendship networks, group leadership and the availability of practical materials. Participants described how familiarity among friends could facilitate communication while simultaneously limiting the involvement of students outside established peer groups.

Student E (P07) observed:

Our friends tend to sit together, which makes conversation easier for us.

The same participant noted that a student outside the usual friendship group contributed less to discussions. This suggested that peer familiarity could both support and constrain collaboration.

Material shortages introduced additional challenges. In School B, students described sharing measuring containers between groups and arranging turns to manage limited equipment. Although this encouraged coordination, waiting periods also contributed to distraction and disengagement.

These findings demonstrated that collaboration was not simply determined by students' willingness to cooperate. It was negotiated within classroom circumstances characterised by unequal access to tasks, established peer relationships and material constraints.

Research Question 3: How did students participate in green chemistry projects in secondary schools in Bayelsa State?

Analysis revealed three major themes: differentiated forms of participation, contextual influences on student involvement and teacher-supported opportunities for increased participation.

Table 3: Themes emerging from students' participation

Theme	Key findings	Supporting participants
Differentiated forms of participation	Students undertook different practical, organisational and explanatory activities, resulting in uneven	P01–P07

	learning opportunities.	
Contextual influences on participation	Confidence, task allocation, environmental relevance, instructional clarity and resource availability shaped involvement.	P01–P07
Teacher-supported participation	Individual encouragement, task reassignment, role rotation and opportunities to explain decisions supported involvement.	P01, P02, P03, P04, P05, P07

Differentiated forms of student participation

The findings indicated that students participated in green chemistry projects through different activities, including handling materials, recording observations, preparing labels, explaining results and cleaning workspaces. However, the nature and extent of participation varied considerably among group members.

Student D (P06) explained:

I collected materials, read the instructions aloud and helped write the conclusion. I only used the measuring container once.

Likewise, Student B (P04) described involvement in labelling and cleaning while observing others undertake practical procedures.

These accounts demonstrated that participation could occur without substantial involvement in the investigative components of a project. Although organisational and supporting activities contributed to project completion, participants distinguished these responsibilities from direct experience with experimental procedures.

Teacher B (P02) reinforced this distinction:

Attendance and carrying materials alone do not show that understanding.

The findings therefore suggested that visible involvement did not necessarily represent equivalent opportunities for scientific learning. Students could contribute to a shared project while experiencing different levels of access to its investigative activities.

Contextual influences on students' participation

Students identified several circumstances that encouraged or restricted their involvement. These included clarity of instructions, confidence in expressing ideas, access to materials, lesson duration and the perceived relevance of project activities.

Environmental relevance emerged as a particularly important source of interest. Student E (P07) stated:

I participate more when I can connect the project with a real problem and when classmates listen.

Similarly, Student C (P05) reported greater involvement when a project presented a problem requiring a solution.

Nevertheless, the findings also revealed barriers that prevented interest from translating into active participation. Student B (P04) described reluctance to contribute when classmates laughed at mistakes, while Student D (P06) identified waiting for materials and short lesson periods as constraints.

These accounts suggested that participation was shaped by the interaction of personal confidence, classroom relationships and practical conditions. Students' willingness to become involved did not independently determine their opportunities to participate.

Teacher-supported opportunities for increased participation

Participants described several teacher practices that helped less-involved students gain access to project activities. These included assigning specific responsibilities, encouraging students privately, rotating roles and requiring individual explanations of group decisions.

Teacher A (P01) explained:

I give a less involved student a specific next task and check that the group allows the student to do it.

Student A (P03) similarly recalled gaining an opportunity to handle a container after the teacher requested role rotation. Student B (P04) described successfully undertaking a measuring task after receiving individual guidance.

However, teacher intervention did not consistently eliminate unequal participation. Some students continued to experience delayed practical turns, while others remained primarily responsible for supporting activities.

Student E (P07) also questioned whether the inclusion of names in group reports accurately represented students' contributions, suggesting that formal recognition of group membership could conceal differences in actual involvement.

Overall, the findings indicated that teacher support could broaden opportunities for participation, but sustained inclusion depended on how responsibilities were distributed throughout project activities.

Discussion of Findings

Objective One: Classroom Culture Surrounding Green Chemistry Projects

The findings revealed that classroom culture surrounding green chemistry projects was characterised by teacher-directed instructional practices, structured safety expectations and limited opportunities for independent student decision-making. Although teachers introduced environmental problems and encouraged group-based practical activities, they maintained considerable control over experimental procedures, materials and classroom decisions. This finding reflects the sociocultural perspective of Lave and Wenger (1991), which emphasises that learning experiences are shaped by the social practices and expectations established within particular educational settings. The predominance of teacher direction suggests that the introduction of green chemistry projects does not necessarily transform conventional classroom practices into participatory learning environments. This finding also relates to Nahlik et al. (2023), who highlighted the importance of pedagogical adaptation in translating green chemistry principles into school-based learning experiences. The implication is that green chemistry projects may provide opportunities for environmental learning while simultaneously reproducing instructional arrangements that restrict students' autonomy. Consequently, the educational significance of green chemistry projects depends not only on their environmental content but also on the classroom practices governing their implementation.

The findings further indicated that classroom culture promoted safety consciousness, careful handling of materials and waste prevention, although students' opportunities to question established procedures differed considerably. Participants described classroom expectations involving the use of small quantities, proper labelling and responsible material disposal. These practices reflected the pollution-prevention orientation of green chemistry emphasised by Anastas and Eghbali (2010). However, some students followed environmental safety rules without fully understanding their underlying scientific justification, suggesting a distinction between procedural compliance and conceptual engagement. Furthermore, while some students reported positive responses to their suggestions, others hesitated to ask questions because of fear of ridicule or restrictive classroom routines. This finding supports Koulougliotis et al. (2024), who identified inquiry-oriented approaches as important components of green chemistry education, but also suggests that opportunities for inquiry may be constrained by the prevailing classroom environment. The findings therefore indicate that a classroom culture supportive of green chemistry education requires more than adherence to safety procedures; it also requires an environment in which students can question established practices, express uncertainty and contribute meaningfully to scientific discussions.

Objective Two: Students' Collaboration in Green Chemistry Projects

The findings demonstrated that collaboration occurred through shared experimental activities, collective problem-solving and discussions of scientific observations. Students described working together to resolve disagreements concerning experimental results, identify procedural errors and manage limited materials. These experiences are consistent with Johnson and Johnson's (2009) social interdependence theory, which explains how appropriately structured cooperative activities can support reasoning, interpersonal relationships and collective learning. The finding also aligns with Karpudewan et al. (2016), who demonstrated the educational relevance of green chemistry activities involving discussion and scientific argumentation among secondary school students. However, the present findings suggest that collaboration was particularly meaningful when students engaged in evaluating evidence and reconsidering scientific explanations rather than merely dividing tasks. Instances in which students compared conflicting results or questioned experimental decisions illustrated opportunities for collective reasoning. Nevertheless, these interactions were not uniformly experienced across groups, indicating that the presence of collaborative activities did not automatically ensure sustained or equitable scientific engagement.

The findings also revealed that collaboration was constrained by unequal task allocation, dominant group members, established friendship networks and limited practical resources. Confident students frequently controlled experimental procedures, while others were assigned recording, labelling or cleaning responsibilities. This pattern challenges the assumption that group-based learning necessarily creates equal opportunities for collaboration. Although Johnson and Johnson (2009) emphasised positive interdependence and individual accountability as important conditions for effective cooperative learning, the participants' accounts suggested that these conditions were not consistently established. Furthermore, friendship-based interactions sometimes facilitated discussion while excluding less socially connected students. Equipment shortages also required groups to share materials, creating opportunities for coordination but occasionally reducing engagement during waiting periods. These findings extend the cooperative learning literature by illustrating how classroom relationships and material circumstances shape collaborative experiences within green chemistry projects. The implication is that effective collaboration requires deliberate attention to task distribution, group organisation and opportunities for individual contribution rather than relying solely on the formation of student groups.

Objective Three: Students' Participation in Green Chemistry Projects

The findings revealed that students participated in green chemistry projects through various activities, including handling experimental materials, recording observations, preparing labels, explaining findings and cleaning workspaces. However, the nature and extent of participation differed considerably among students, with some actively undertaking investigative tasks while others remained largely involved in supporting activities. This finding aligns with Lave and Wenger's (1991) situated learning theory, which regards participation as a fundamental process through which individuals develop knowledge and competence within social settings. Nevertheless, the findings suggest that participation should not be assessed solely through students' physical presence or contributions to completed group projects. Students who performed organisational tasks without opportunities to handle materials or explain scientific decisions experienced a different form of involvement from those undertaking experimental procedures. This observation is consistent with the emphasis on active and inquiry-oriented learning identified by Koulougliotis et al. (2024). However, it also reveals an important limitation of project-based instructional arrangements: participation may appear widespread at the group level while meaningful investigative opportunities remain concentrated among particular students. Consequently, evaluating participation in green chemistry projects requires attention to the quality and nature of students' involvement rather than the completion of assigned activities alone.

The findings further indicated that students' participation was influenced by confidence, instructional clarity, access to materials, environmental relevance and teacher support. Students

reported greater willingness to participate when project activities addressed familiar environmental problems and when classmates responded positively to their contributions. Conversely, fear of ridicule, limited equipment and unequal allocation of responsibilities restricted participation. These findings reinforce the argument of Lave and Wenger (1991) that opportunities for learning are shaped by the social arrangements through which individuals gain access to meaningful activities. The findings also complement Karpudewan et al. (2016), whose investigation highlighted the educational potential of green chemistry activities that engage students in scientific reasoning and discussion. Importantly, teacher interventions such as role rotation, individual encouragement and task reassignment appeared to improve opportunities for participation, although they did not completely eliminate existing inequalities. This suggests that meaningful participation is not an automatic consequence of introducing green chemistry projects but requires deliberate pedagogical practices that distribute learning opportunities more equitably. Within the environmental context of Bayelsa State, the findings further suggest that connecting green chemistry activities with familiar environmental concerns may encourage students' interest, provided that classroom arrangements allow them to translate that interest into active involvement. Thus, the development of inclusive green chemistry education requires attention to both the environmental relevance of learning activities and the everyday classroom conditions that enable students to participate meaningfully.

CONCLUSION

The study concludes that classroom culture, collaboration and participation are important dimensions of students' experiences of green chemistry projects in secondary schools in Bayelsa State, Nigeria. The findings revealed that classroom culture was predominantly teacher-directed, with established safety expectations and limited opportunities for independent student decision-making. Although collaborative activities encouraged shared problem-solving and scientific discussion, unequal task allocation, dominant group members and inadequate instructional resources constrained effective cooperation. Similarly, students' participation varied considerably, as differences in confidence, access to practical tasks and classroom interactions influenced their involvement in project activities. Teacher interventions, particularly role rotation, individual encouragement and task redistribution, emerged as important practices for improving students' opportunities to contribute. These findings suggest that incorporating green chemistry projects into secondary school instruction does not automatically guarantee collaborative or participatory learning experiences. Rather, meaningful engagement depends on classroom practices that promote inclusive interaction, equitable responsibility and active involvement in scientific inquiry. The study therefore underscores the need for chemistry teachers to create supportive classroom environments that encourage students' contributions, strengthen collaborative practices and provide equitable opportunities for practical participation, thereby enhancing the educational relevance of green chemistry projects within the environmental context of Bayelsa State.

RECOMMENDATIONS

1. Chemistry teachers should foster supportive classroom cultures that encourage students' independent thinking, questioning and active engagement in green chemistry projects.
2. Chemistry teachers should promote effective collaboration through equitable task allocation, systematic role rotation and inclusive group activities.
3. School administrators should provide adequate instructional resources and support teachers in creating opportunities for all students to participate meaningfully in green chemistry projects.

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