Culturally Responsive Pedagogy in Science Education A Conceptual Study

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Abstract

In the culturally rich and diverse context of India, science education presents both opportunities and challenges in addressing the varied socio-cultural experiences of learners. This qualitative conceptual study examines the significance and application of Culturally Responsive Pedagogy (CRP) within science education in Indian schools. The primary objectives of the study are to explore the theoretical evolution of CRP, assess its relevance to science education, and examine its applicability in Indian classroom settings.

Adopting a qualitative conceptual framework, the study undertakes an interpretative analysis of key theoretical perspectives, educational frameworks, national education policies, and contemporary scholarly literature. The thematic analysis identifies five central dimensions shaping culturally responsive science education: the cultural context of science learning; the role of identity and representation; the significance of language and communication; the influence of teacher beliefs and competencies; and the potential of science education to advance social justice.

The findings suggest that integrating culturally responsive practices into science classrooms can enhance student engagement, promote equity, and strengthen critical scientific literacy. The study further underscores the need to align curriculum design, teacher education, and educational policy with culturally responsive principles to foster inclusive and transformative science education in India.

Keywords: Multiple Disabilities, Co-scholastic Activities, Inclusion, ADL Skills

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Introduction

Science education plays a vital role in fostering analytical thinking, problem-solving abilities, and intellectual curiosity among students, thereby preparing individuals to engage thoughtfully with the complexities of contemporary society (Osborne, 2010). However, conventional approaches to science teaching often assume a culturally neutral stance, overlooking the rich and diverse socio-cultural backgrounds that students bring into the classroom. In a country such as India—characterised by the profound diversity in language, caste, religion, region, and socio-economic status—the implications of a standardised approach to science education are significant. Such an approach risks alienating large sections of learners whose lived experiences and knowledge systems remain underrepresented in curricula and pedagogical practices.

Historically, science education in India has largely relied on frameworks developed in Western contexts, privileging dominant epistemologies while marginalising indigenous knowledge systems and culturally situated ways of knowing (Kumar, 1991). This reliance has contributed to a disconnect between formal science education and students' everyday realities, particularly for learners from historically marginalised communities (Basu and Barton, 2007). In the absence of contextual relevance, science is often perceived as an abstract, inaccessible, and detached from social concerns, leading to disengagement and the underrepresentation of certain groups in STEM fields.

In recent years, Culturally Responsive Pedagogy (CRP) has emerged as a promising approach to addressing these challenges. CRP advocates recognising and integrating students' cultural references across all aspects of learning, thereby making education more inclusive, meaningful, and empowering (Gay, 2010). Within science education, this approach entails linking scientific concepts to students' lived experiences, valuing diverse knowledge traditions, and cultivating learning environments in which all learners feel respected, capable, and supported in achieving success.

The conceptual foundations of culturally responsive pedagogy are not limited to Western scholarship. Indian educationists have long articulated parallel principles within the context of multilingual and multicultural classrooms. Krishna Kumar (1991) critiques the historical dominance of homogenised curricula, noting that such frameworks often marginalise learners whose cultural and linguistic realities differ from those reflected in textbooks. Similarly, A. Mohanty (2009), a leading scholar in multilingual education, underscores the importance of mother tongue and regional languages in strengthening conceptual understanding, particularly in science education, where abstract ideas benefit from culturally familiar frames of reference. Policy documents such as the Yash Pal Committee Report (1993) and the National Curriculum Framework (2005) explicitly advocate the integration of local knowledge systems and children's home languages into classroom instruction, closely aligning with the principles of CRP. Further studies reinforce the need to recognise indigenous knowledge traditions, cautioning that exclusionary language policies may perpetuate structural inequities. Collectively, these contributions affirm that culturally responsive pedagogy is deeply rooted in India's own educational thought, underscoring its relevance for reimagining equitable and inclusive science education.

Need and Significance of the Study

Globally, there is growing recognition that education should not merely transmit knowledge but also acknowledge, value, and utilise cultural diversity as a pedagogical resource (Ladson-Billings, 1995). In the Indian context, the need for culturally responsive approaches is underscored by persistent educational disparities across social groups, despite constitutional guarantees and policy initiatives such as the National Education Policy (NEP) 2020.

The NEP 2020 emphasises inclusive, multidisciplinary, and learner-centred education that recognises the diverse backgrounds of students and promotes experiential and inquiry-based learning. Building on this vision, the National Curriculum Framework for School Education (NCF-SE) 2023 stresses the importance of contextualising knowledge, nurturing critical thinking, and grounding scientific inquiry in learners' socio-cultural realities. It advances an educational framework that values "diverse knowledge traditions" and integrates scientific understanding with students' everyday life experiences.

Scientific literacy today extends beyond the memorisation of facts; it encompasses the development of critical inquiry, ethical reasoning, and the ability to apply scientific knowledge to real-world problems (Bybee, 1997). When science education disregards students' cultural perspectives, it risks perpetuating social exclusion and inequality. A culturally relevant approach to science education offers pathways to bridge these gaps by embedding scientific concepts within students' cultural narratives, thereby enhancing engagement, deepening understanding, and supporting academic achievement (Aikenhead, 2001).

Given India's aspirations to become a knowledge-based economy and a global leader in innovation, democratising access to high-quality science education across all sections of society is imperative. Integrating culturally responsive pedagogy into science education not only promotes educational equity but also cultivates a more critical, innovative, and socially responsible scientific community.

Although a substantial body of research has established the theoretical foundations and demonstrated the effectiveness of culturally responsive pedagogy, much of this scholarship has emerged from Western contexts, particularly the United States (Villegas and Lucas, 2002; Gay, 2010). The complex socio-cultural dynamics of Indian classrooms — shaped by the intersections of caste, class, language, gender, and religion — call for more contextually grounded explorations of CRP.

Science education in India continues to be constrained by examination-oriented practices, rigid curricula, and limited integration of learners' socio-cultural knowledge. While policy initiatives such as NEP 2020 and NCF-SE 2023 create significant opportunities for reform, concrete models and pedagogical frameworks for implementing culturally responsive science education in Indian schools remain underdeveloped.

This study, therefore, seeks to conceptually examine the theoretical foundations of culturally responsive pedagogy within the Indian context, with particular reference to science education, and to propose pathways for making science teaching more culturally relevant, equitable, and socially just. It responds to the pressing need to reconceptualise pedagogy not merely as content transmission, but as an inclusive, dynamic, and culturally affirming process.

Objectives of the Study

The main objectives of this study are:

- To trace the theoretical development and core concepts of culturally responsive pedagogy;
- To synthesise insights from national education policies, educational research, and theoretical frameworks that inform culturally responsive science instruction;
- To develop thematic dimensions and conceptual frameworks to support the integration of culturally responsive pedagogy into science curricula and pedagogical practices in Indian schools;
- To examine the application of culturally responsive pedagogy within Indian science education and to propose directions for inclusive research, policy formulation, and educational practice.

Review of Literature

Foundations of Culturally Responsive Pedagogy (CRP)

Ladson-Billings (1995), in "Toward a Theory of Culturally Relevant Pedagogy," sought to identify pedagogical practices that promote students' intellectual, social, emotional, and political empowerment. Drawing on qualitative case studies of effective teachers, she articulated three core criteria of culturally relevant pedagogy: academic achievement, cultural competence, and critical consciousness. Her findings demonstrate that culturally relevant education fosters holistic student development.

Similarly, Gay (2010), in *Culturally Responsive Teaching: Theory, Research, and Practice,* aimed to deepen understanding of culturally responsive pedagogy by emphasising the integration of students' cultural knowledge, lived experiences, and learning preferences into instructional practices. Through an extensive review of empirical and theoretical literature, Gay demonstrated that students' cultural contexts significantly influence academic engagement and achievement. The study concludes that equitable educational outcomes require the affirmation and inclusion of diverse cultural identities within classroom practices.

Culturally Responsive Pedagogy in Science Education

Moll *et al.* (2009), in their foundational work on "Funds of Knowledge for Teaching", sought to document and utilise the everyday knowledge embedded within households for educational purposes. Employing ethnographic research in Latino communities, the authors demonstrated that, families possess rich and complex knowledge systems that can meaningfully inform classroom instruction. Their findings highlight that, recognising community-based knowledge helps to bridge learning experiences between home and school.

Aikenhead (1996), in "Science Education: Border Crossing into the Subculture of Science," examined students' experiences of science learning when their home cultures differ from the dominant culture of school science. Using ethnographic methods, he found that students often face difficulties in navigating these cultural "border crossings." The study concludes that culturally responsive approaches in science education can ease these transitions and enhance conceptual understanding.

Basu and Barton (2007), in their study, "Developing a Sustained Interest in Science among Urban Minority Youth," investigated the role of cultural relevance in shaping students' engagement with science. Through longitudinal case studies of urban youth, they found that students demonstrated deeper and more sustained interest in science when learning experiences were connected to their personal and cultural identities. The study underscores the importance of curriculum design grounded in learners' cultural contexts.

Lee and Buxton (2010), in *Diversity and Equity in Science Education: Research, Policy, and Practice*, examined systemic barriers of participation and success in STEM education. Drawing on policy analysis and case study research, they found that culturally responsive pedagogical approaches significantly enhance the engagement and achievement of students from historically marginalised groups. The authors conclude that addressing diversity and equity requires intentional integration of cultural considerations into both curriculum design and instructional practices.

Indian Context: Policies and Reports

The National Curriculum Framework (NCF) 2005 highlighted the importance of connecting knowledge to learners' real-life experiences beyond the classroom. It emphasised the integration of local contexts into education and advocated learning that is both relevant and inclusive. The framework recommended a shift away from rote memorisation towards hands-on and experiential learning practices. Its conclusions supported curriculum reforms rooted in cultural and social realities.

The National Education Policy (NEP) 2020, aimed to ensure that education reflects India's vast cultural diversity. Through a synthesis of policy priorities, it recommended instruction in the mother tongue during the foundational stage, the integration of indigenous knowledge systems into subjects such as science and mathematics, and the promotion of critical and creative thinking. The policy underscored the need for inclusive and culturally responsive education across disciplines, including science.

The National Curriculum Framework for School Education (NCF-SE) 2023 further advanced these ideas by advocating interdisciplinary and experiential approaches to science education grounded in local knowledge systems. Policy analysis within the framework highlights the necessity of culturally responsive pedagogies and the use of critical inquiry-based approaches. The document emphasises the pivotal role of teachers in linking scientific concepts to students' lived experiences.

Theoretical Models Supporting CRP in Science Education

Aikenhead's Cultural Border Crossing Model (1996) conceptualises science learning as a process in which students navigate between their everyday cultural worlds and the subculture of school science. Drawing on ethnographic research, Aikenhead argued that teachers should function as "cultural brokers" to facilitate this transition. His findings suggest that reducing cultural dissonance or "culture shock" in science classrooms enhances student understanding and learning outcomes.

Villegas and Lucas (2002), in "Educating Culturally Responsive Teachers," proposed a six-strand framework encompassing socio-cultural consciousness, affirming diversity, and a commitment to social justice, among other dimensions. Based on a synthesis of existing literature and an analysis of teacher education programmes, they concluded that equipping teachers with strong socio-cultural awareness, is essential for the effective implementation of culturally responsive pedagogy.

Banks' Transformative Approach (2009) offered a model for curriculum restructuring, that moves beyond the superficial inclusion of diverse content towards fostering critical consciousness among students. Drawing on meta-analytic research, Banks emphasised that meaningful educational equity requires deep curricular transformation rather than additive reforms. His work advocates substantial structural changes in curriculum design and pedagogical practices.

Rationale of the Study

The present study is grounded in an extensive review of theoretical and empirical literature on Culturally Responsive Pedagogy (CRP) in science education, with particular reference to the Indian context. Existing studies highlight key dimensions of CRP while simultaneously revealing significant gaps that this research seeks to address.

Theoretical Foundations of Culturally Responsive Pedagogy

Seminal works by Ladson-Billings (1995) and Gay (2010) established the foundational principles of culturally responsive Pedagogy, emphasising the academic achievement, cultural competence, and critical consciousness. These studies underscore the need for pedagogical approaches that affirm diverse identities and integrate cultural understanding into teaching and learning processes. However, despite their strong theoretical grounding, the application of these models to discipline-specific domains such as science education—particularly in non-Western contexts—remains underexplored.

Applications of CRP in Science Education

Research by Aikenhead (1996), Moll *et al.* (1992), and Basu and Barton (2007) demonstrates that culturally grounded approaches to science teaching enhance student engagement and scientific literacy. Aikenhead's Cultural Border Crossing model, in particular, addresses the need to bridge students' everyday experiences with the epistemic culture of science. Nevertheless, much of the existing literature focuses on Western contexts or urban minority populations, pointing to a critical need for studies examining CRP practices within the diverse realities of Indian school settings.

Policy Directions Supporting CRP

Policy frameworks such as the National Curriculum Framework (2005), the National Education Policy (2020), and the National Curriculum Framework for School Education (2023) advocate the integration of local knowledge systems, multilingual education, and experiential learning. These policy documents position cultural relevance as central to science education.

However, there remains a limited systematic analysis of how these policy directives are enacted in everyday classroom practices, particularly in rural and semi-urban schools across India.

Models Informing the Study

Theoretical models such as Aikenhead's Cultural Border Crossing framework (1996), Banks' Transformative Approach (2009), and the framework proposed by Villegas and Lucas (2002) offer valuable conceptual lenses for this study. Despite their relevance, empirical research adapting these models to the Indian science education context remains a limited, especially in light of the country's extensive cultural, linguistic, and socio-economic diversity.

Knowledge Gaps Identified

- Absence of discipline-specific (science) CRP frameworks tailored to Indian educational institutions.
- Limited empirical studies linking policy directives such as NEP 2020 and NCF-SE 2023 to the actual implementation of CRP in science classrooms.
- Fragmented empirical evidence and the lack of a coherent conceptual framework for the culturally relevant science education in India.
- Minimal adaptation of existing CRP models (for example, the Cultural Border Crossing model) to suit the Indian socio-cultural context.
- Insufficient research addressing rural, regional, and linguistic variations in science teaching from a CRP perspective.

Methodology

Research Approach

This research adopts a qualitative conceptual methodology aimed at synthesising existing theories, frameworks, and policy discourses to develop a comprehensive understanding of culturally responsive pedagogy (CRP) in science education in India. Conceptual research foregrounds theoretical constructs and abstract ideas and typically does not involve direct empirical data collection; instead, it seeks to explore and explain complex phenomena through systematic analysis of existing knowledge (Jabareen 2009).

Research Method

The study is non-empirical in nature and relies on the secondary sources such as peer-reviewed journal articles, scholarly books, policy documents, and curriculum frameworks. This approach involves a critical examination and interpretative analysis of existing literature, in order to construct, a theoretical framework that addresses the stated research problem (Jabareen 2009).

Research Design

This research employs a thematic synthesis approach, which is particularly suited to integrating findings from multiple qualitative studies. Thematic synthesis involves three key stages:

- Line-by-line coding of textual data,
- development of descriptive themes, and
- generation of analytical themes that extend beyond the findings of the original studies (Thomas and Harden 2008).

This method facilitates the identification of recurring patterns and themes across diverse sources, thereby strengthening conceptual understanding of CRP in science education. In addition, Braun and Clarke's (2006) six-phase framework for thematic analysis guided the analytical process, as follow:

- Familiarisation with the literature,
- generation of initial codes,
- identification and grouping of themes,
- review of themes for coherence and consistency,
- definition and naming of themes, and
- production of a structured analytical narrative.

Thematic Analysis

The thematic analysis of the reviewed literature and policy documents reveals five key dimensions that significantly shape the development and implementation CRP in science education, particularly within the Indian school context. Each of these themes highlights critical areas for both theoretical advancement and practical intervention.

Cultural Context of Science Learning

The first prominent theme concerns the cultural context of science learning. Several scholars (Aikenhead 1996; Jegede 1995) have observed that the conventional science curricula often present knowledge as culturally neutral and universally objective, overlooking the ways in which scientific understanding is embedded within specific cultural contexts. In India, where learners come from diverse backgrounds—including tribal, rural, urban, and indigenous communities—a science curriculum disconnected from students' lived experiences may alienate rather than engage them. NEP 2020 and NCF-SE 2023 explicitly emphasise the integration of indigenous knowledge systems, local contexts, and traditional ecological knowledge into mainstream science education. Contextualising science learning not only enhances cognitive engagement, but also promotes epistemic justice by recognising students' cultural experiences as legitimate sources of knowledge.

When curricula disregard learners' local practices and ecological knowledge, structural tensions emerge, that weaken student engagement. In India, a centralised and examination-driven syllabus often privileges decontextualised, textbook-based content, leaving limited scope for place-based and experiential science learning (Batra 2005). This misalignment diminishes the perceived relevance of science education for students in rural and tribal areas, where everyday experiences could otherwise serve as a meaningful entry points for the conceptual understanding. Over time, such disconnection may contribute to the declining interest in science and the continued underrepresentation of these groups in STEM-related higher education and careers.

Importance of Identity and Representation

The second major theme relates to identity and representation in science education. Research suggests that when students see their cultural, linguistic, and social identities affirmatively reflected in curricula and classroom interactions, they are more likely to develop a sense of belonging and confidence in their academic capabilities (Gay 2010; Banks 2016). In the Indian context, dimensions, such as caste, gender, religion, and regional identity significantly shape students' educational experiences. Studies (e.g. Subrahmanian 2010; Batra 2020) indicate that marginalised learners are often excluded from dominant scientific narratives that privilege upper-caste, urban, and male perspectives.

Culturally responsive science pedagogy, therefore, requires deliberate efforts to include diverse scientific contributions, examples drawn from varied socio-cultural settings, and recognition of multiple ways of knowing. Representation in this sense is not merely additive; it is transformative, as it challenges dominant epistemologies and supports the creation of inclusive and equitable science learning environments.

Role of Language and Communication

Language and communication emerge as a third critical dimension within the literature. Lee (2005) and Mohanty (2009) argue that language functions not only as a medium of instruction but also as a carrier of culture, identity, and cognition. In multilingual societies such as India, where students may speak tribal languages, regional dialects, and Hindi or English as additional languages, the dominance of English in science education often marginalises learners from non-dominant linguistic backgrounds. The NEP 2020 advocates mother-tongue or home-language instruction, at least in the foundational years, recognising that conceptual understanding develops most effectively through familiar linguistic frameworks.

Empirical studies (for example Panda and Mohanty 2009) demonstrate that the use of students' home languages in science classrooms enhances comprehension skills, critical reasoning, and classroom participation. Accordingly, the adoption of multilingual pedagogies, translanguaging practices, and culturally sensitive communication strategies is essential for creating inclusive science classrooms that support all learners.

Linguistic tensions are particularly evident in the medium of instruction. Mohanty (2009) notes that when science education is delivered exclusively in a dominant language, students from non-dominant linguistic communities experience increased cognitive load, which hampers their ability to grasp abstract scientific concepts. This situation reflects what Jegede (1996) describes as a "cultural border-crossing" challenge, wherein learners must navigate between the linguistic and epistemic worldviews of their home environments and those of school science, often without adequate pedagogical support. Such barriers may lead to lower academic achievement, reduced participation, and a sense of alienation from science as a discipline.

Impact of Teacher Beliefs and Competencies

The fourth theme highlights how teacher beliefs and skills influence the implementation of CRP in science classrooms. Educators' views on cultural diversity, their awareness of socio-political issues, and their teaching abilities significantly affect the effective implementation of culturally responsive practices (Villegas and Lucas, 2002; Ladson-Billings, 1995). In India, teacher education initiatives have traditionally concentrated on content transmission and exam results while giving little consideration to cultural sensitivity. Recent research (Pathak and Srivastava, 2019) shows that although numerous Indian teachers recognise their students' diversity, they frequently do not possess the conceptual resources and training necessary to incorporate cultural knowledge into science teaching. Moreover, existing ideas of science as unbiased and free from cultural influences foster opposition to culturally sensitive methods. Enhancing teacher skills via pre-service and in-service training, reflective methods, and mentorship initiatives is essential for making science education a culturally sustaining effort.

Potential of Science Education to Foster Social Justice

Ultimately, the thematic analysis underscores the capacity of science education to serve as an effective means for advancing social justice. Conventional science teaching has frequently been involved in supporting prevailing perspectives, while sidelining indigenous wisdom and different ways of knowing (Harding, 1998; Shiva, 2000). In contrast, a culturally responsive approach aims to democratise science education, enabling students to link scientific exploration with themes of equity, sustainability, and community empowerment. In India, where systemic disparities rooted in caste, class, gender, and region still influence access to quality education, incorporating social justice viewpoints into science teaching is essential. Examples comprise instructing science via community-oriented initiatives, examining the social aspects of scientific progress, and promoting a critical analysis of the processes involved in producing scientific knowledge. These methods can cultivate students into knowledgeable, analytical, and socially accountable citizens, capable of making significant contributions to a diverse democracy.

Addressing these inequities requires transformative policy and curricular reform. Building on NEP 2020 and NCF-SE 2023, science curricula should be redesigned to include culturally relevant case studies, indigenous knowledge systems, and region-specific examples (Bybee, 1997). Teacher education programmes must embed CRP-focused training, preparing educators to integrate multilingual strategies and community-based science projects into their pedagogy (Gay, 2010). Assessment reforms should move away from rote-based, high-stakes models towards performance-based evaluation that values applied understanding, collaborative problem-solving, and community-linked science projects. Without such changes, dominant cultural narratives will continue to hold disproportionate power, perpetuating inequities in science education access and achievement.

Taken together, the structural and cultural conflicts outlined across the thematic analysis illustrate that current science education frameworks in India still reflect significant inequities. These inequities manifest in constrained teacher agency, linguistically exclusive instruction, and limited curricular flexibility to address local realities. By implementing transformative reforms—ranging from curriculum redesign and teacher professional development to assessment restructuring—educators and policymakers can create a learning environment where CRP principles are not merely aspirational but operational. This shift would not only enhance learning outcomes for marginalised groups, but also going to broaden participation in science, helping to cultivate a more socially just and scientifically literate society.

Conclusion and Implications

This conceptual research article has examined the key dimensions of CRP in science education, with particular reference to the Indian educational context. Drawing on a thematic analysis of theoretical frameworks, policy documents, and empirical studies, the review identified five interrelated domains shaping the development and implementation of culturally responsive science teaching: cultural contextualisation of science learning, identity and representation, language and communication, teacher beliefs and competencies, and the role of science education in advancing social justice.

Collectively, these dimensions underscore the need to make science education more inclusive, locally relevant, and socially meaningful. Policy frameworks such as the NEP 2020 and NCF-SE 2023 advocate a shift from uniform, standardised approaches towards context-sensitive and learner-centred models of education. However, such a transition requires more than policy articulation; it calls for substantive changes in curriculum design, teacher education, and classroom practice.

Cultural contextualisation should be understood not as a superficial enrichment of scientific content but as a fundamental rethinking of how knowledge is produced, validated, and communicated across diverse learning environments. Science instruction that draws upon the students' lived experiences, indigenous knowledge systems, and local ecological contexts, fosters deeper conceptual engagement and relevance. Similarly, affirming students' identities and ensuring diverse representation within scientific narratives and pedagogical practices enhances learners' sense of belonging, motivation, and sustained academic achievement.

Language emerges as a critical cognitive and cultural resource in making science accessible and meaningful. Multilingual and translanguaging approaches are not only pedagogically effective but also ethically imperative in a linguistically diverse country such as India. Teachers play a pivotal role in translating culturally responsive principles into classroom practice; their beliefs, preparedness, and ongoing professional development determine whether science classrooms function as spaces of inclusion or exclusion. Furthermore, science education holds significant potential to advance social justice by addressing structural inequalities, validating multiple epistemologies, and enabling learners to critically engage with science as a tool for sustainable and equitable development.

Several important implications follow from these findings. Firstly, curriculum and textbook reform is essential. Science curricula should integrate community knowledge systems, culturally relevant examples, and locally meaningful issues, while systematically including the contributions of scientists from diverse social and geographical backgrounds, particularly from the Global South. Secondly, teacher education and professional development programmes must position CRP as a core component, encompassing cultural awareness, reflective practice, linguistic sensitivity, and critical engagement with the relationship between science and society. Thirdly, language policy implementation requires concrete support through the development of localised learning materials and teacher training in multilingual and translanguaging pedagogies. Fourthly, policy-practice integration remains crucial. While NEP 2020 and NCF-SE 2023 provide a progressive vision, effective mechanisms for local implementation, monitoring, and community engagement must be established. Finally, future research and model development should prioritise the creation of contextually grounded CRP frameworks tailored to Indian science classrooms, supported by empirical studies across diverse regional and socio-linguistic settings.

The practical relevance of CRP in Indian science education is evident in several successful school-level initiatives. For example, multilingual science pedagogy projects in Zilla Parishad schools in Maharashtra, supported by the Homi Bhabha Centre for Science Education (HBCSE), have integrated local dialects, community examples, and hands-on activities into physics and biology instruction. These initiatives have improved conceptual understanding among first-generation learners and increased participation, particularly among girls. Similarly, the Eklavya Science Education Programme in Madhya Pradesh has demonstrated the value of embedding locally relevant case studies and indigenous practices within science curricula through collaboration with village communities, resulting in measurable gains in understanding and student confidence. In Odisha, the Multilingual Education (MLE) Project, led by the state government and supported by the Centre for Multilingual Education, JNU, enabled students in tribal schools to learn scientific concepts initially in their mother tongue before transitioning to Odia and English, leading to reduced dropout rates and stronger engagement with STEM subjects (Mohanty 2009).

These examples illustrate that CRP is not merely a theoretical construct but a flexible and effective pedagogical approach capable of transforming science education across diverse Indian contexts when supported by culturally grounded curricula, multilingual practices, and community participation. The observed improvements in comprehension, participation, and retention demonstrate that culturally responsive pedagogy offers a viable pathway towards inclusive, equitable, and socially just science education in India.

In conclusion, CRP in science education represents not only a pedagogical strategy but also a philosophical commitment to equity, diversity, and democratic participation. In Indian classrooms, where diversity is the norm rather than the exception, culturally responsive science education can promote deeper learning, strengthen social cohesion, and contribute to nation-building grounded in pluralism. By synthesising global theoretical perspectives with indigenous educational traditions and policy directions, this conceptual study provides a foundation for continued research, practice, and innovation in science education.

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