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# Toward Transformative Science Pedagogy: Critical Insights from Government Schools of NCT of Delhi

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***ABSTRACT:***

*Science education plays an important role to develop scientific temperament, critical thinking, and imagination among students. Within the Indian schooling system and particularly in Delhi's government schools, science teaching carries the potential to empower children from disadvantaged backgrounds of non-critical thinking by enabling them to make sense of their everyday life and prepare them to participate more in society. This study examines the state of science education in government schools of NCT of Delhi, focusing on the conflict between traditional textbook-led teaching and the inquiry-based practices models promoted through recent initiatives. The analysis draws entirely on secondary sources such as government policy documents, reports and academic research. Reform measures like Mission Chunauti (2016), Mission Buniyaad, the expansion of ICT and digital classrooms and STEM-focused initiatives were all introduced with the aim to make science teaching more inquiry-driven. Recent policy frameworks strongly endorse Inquiry-Based Science Education (IBSE), which emphasises questioning, exploration and hands-on experiments. However, the reality in most classrooms still reflects conventional practice—rote memorisation, exam-driven teaching and heavily reliance on prescribed textbooks. These findings suggest that although IBSE is well represented in policy discourse and is visible in small pockets of practice. However, its wider adoption faces several barriers. These include inadequate preparation of teachers, insufficient infrastructural support, rigid curricular and assessment frameworks. The paper concludes that bridging this gap between policy and classroom reality requires sustained attention to three areas:- Subject-specific professional development for teachers, flexible curricular design and investment in digital and science specific infrastructure. By taking these steps, classrooms of government school can shift away from*

*rote memorization to real scientific learning that inspires curiosity and builds critical thinking in students.*

***Keywords:*** *Educational reforms, Science education, National Education Policy (NEP 2020), inquiry-based learning, Government schools of NCT of Delhi.*

## 1. INTRODUCTION:

In spite of progressive education policies, science education in Delhi's government schools still relies on traditional, lecture-based methods, exam-driven teaching rather than the inquiry-based approaches advocated by modern reforms. The majority of classrooms still place a strong emphasis on rote memorization and exam-focused learning, despite efforts like the Happiness Curriculum and the 'National Education Policy (NEP) 2020' to move the emphasis toward learner-centric, experiential models.

### 1.1 The Persistence of Traditional Teaching Methods:

India's science curriculum has been criticized for decades for emphasizing memorization over in-depth comprehension. The way science is taught in Delhi's government schools is still influenced by old traditional methods and customs. Textbooks and lectures continue to be the main teaching tools in many classrooms. As a result, rather than being active participants in the learning process, students are passive listeners.

The **Central Board of Secondary Education's (CBSE)**, which strongly emphasizes performance on standardized tests and factual accuracy, is a major contributing factor to this pattern. There is little room for experiment, questioning or problem-solving in this framework, however all of these are crucial for fostering critical thinking and scientific reasoning in the students. On the other hand, **'Inquiry-Based Science Education (IBSE)'** focus on alternate substitute which helps students to shift away from traditional rote memorization to a deeper conceptual understanding by promoting inquiry, experiment, imagination and problem-solving. Such progressive, constructivist and experiment-oriented pedagogies have been emphasized in national policy documents such as the **'National Curriculum Framework (2005)'** and the **'National Education Policy (2020)'**.

### 1.2 Reform Initiatives and Implementation Challenges:

A number of reform initiatives have also been implemented in Delhi with the goal of revitalizing government school education. The government's dedication to enhancing educational opportunities is demonstrated by initiatives like **Mission Chunauti (2016),** Happiness Curriculum, Mission Buniyaad, the creation of STEM clubs and virtual classrooms. Even though these actions are a significant step forward, the main obstacle still stands:- converting policy goals into regular classroom instruction. There is an urgent need for resources, flexible curricula and ongoing support for teachers if science is to be perceived as a process of inquiry, experiment and discovery rather than as a collection of facts. While not all were designed specifically for science, these initiatives have indirectly shaped science teaching by promoting differentiated instruction, improving infrastructure and introducing digital resources **(Banerjee et al., 2020; Raina, 2021)**. Activities like Science Week and project-based exhibitions have also attempted to encourage inquiry and creativity, aligning in spirit with IBSE.

Yet, the gap between policy vision and classroom reality remains wide. Teachers—key to any pedagogical transformation—continue to face systemic obstacles such as overcrowded classes, poorly equipped laboratories, rigid curricula and inadequate subject-specific training **(Batra, 2009; Sharma & Chattopadhyay, 2021)**. Opportunities for professional development are sporadic and rarely tailored to the unique needs of science educators. Even when digital technologies are introduced, they are often used passively, for demonstration rather than for interactive exploration **(Raina, 2021).**

### 1.3 Assessment Systems and Their Impact on Pedagogy:

Assessment systems further exacerbate the challenge. High-stakes board examinations drive teachers to prioritise syllabus coverage and test preparation over meaningful engagement with content. As **Rampal (2001)** notes, this obsession with "covering content" ultimately stifles curiosity, imagination and student voice. Consequently, although IBSE is firmly embedded in policy discourse, its actual implementation in classrooms remains limited.

## 2. Research Aims:

This study, drawing exclusively on secondary sources—government reports, policy papers and academic studies—interrogates the gap between policy intent and classroom practice in science education in Delhi. It explores the difference between traditional, examination-driven approaches and inquiry-based pedagogies, while also identifying the systemic conditions that perpetuate this divide. By doing so, the study aims to contribute to wider debates on how science education in government schools can become more inquiry-led, inclusive and responsive to learners' everyday life.

## 3. Research Questions:

The study is pioneered by the following research questions:

**3.1** How recent educational reforms in Delhi influenced the pedagogical practices used for teaching science in government schools?

**3.2** To what extent do science classrooms reflect a balance between conventional methods and inquiry-based approaches?

**3.3** What traditional and classroom-level challenges limit the effective implementation of 'Inquiry-based science education (IBSE)'?

## 4. Methodology:

This research adopts a qualitative and interpretive approach, relying entirely on secondary sources to analyse the state of science teaching in government schools of NCT of Delhi. Since the study does not include primary fieldwork or interviews, its emphasis is on critically examining existing policy documents, scholarly literature and research reports. The aim is to unpack the ongoing debate between traditional and inquiry-based pedagogies, assess the impact of recent reforms and identify the systemic conditions that shape or constrain pedagogical change.

The selection of sources was guided by considerations of credibility, relevance and currency. The study draws on:

- **Empirical evaluations** of Delhi's educational reform programmes, including Mission '*Chunauti (2016)'*, '*Mission Buniyaad'* and technology-enabled learning initiatives ('Banerjee et al., 2020; Raina, 2021').
- **Reports from educational organisations and think tank** such as 'Pratham', the 'Azim Premji Foundation' and 'Jameel Poverty Action Lab' ('Banerjee et al., 2020; Banerji & Chavan, 2016').
- **Academic literature** on science education reform and pedagogy in India (e.g., 'Batra, 2005, 2009; Kumar, 1991; Yadav, 2018').
- **Policy Frameworks** i.e. 'National Curriculum Framework (2005)', 'National Education Policy (2020)' and NCERT position papers on science education ('NCERT, 2006; Ministry of Education, 2020').

The study intends to highlight the advantages and disadvantages of introducing inquiry-based science learning in Delhi's government schools.

## 5. Findings and Discussion:

The findings from secondary source are thematically analysed in this section and arranged into four interconnected dimensions:- (i) The persistence and dominance of traditional science pedagogy, (ii) The partial and uneven adoption of 'inquiry-based science education (IBSE)', (iii) Delhi's educational reforms' impact on science pedagogy, (iv) The structural obstacles preventing pedagogical change.

The findings do not emerge from primary fieldwork; rather, they reflect patterns repeatedly documented in policy reports, scholarly research and evaluations of reform initiatives.

### 5.1 The Persistence of Traditional Science Pedagogy:

While reforms encourage more student-focused approaches, the everyday reality of science teaching in Delhi's state schools is still marked by conventional, teacher-led practices. Instruction is still anchored in textbooks, lectures and exam preparation **(Batra, 2005; Kumar, 1991).** Studies repeatedly show that classroom practice is often reduced to content delivery, with teachers explaining concepts from the book and students reproducing them in standardised tests **(Yadav, 2018; NCERT, 2006).**

The CBSE curriculum and its assessment framework play a central role in this persistence. Teachers face pressure to complete extensive syllabi within fixed timelines, leaving little scope for experimentation. In Classes IX and X, where board examinations dominate, teachers focus heavily on factual recall and objective-type questions, side-lining inquiry or conceptual exploration **(Rampal, 2001).** Administrative expectations further reinforce this conservatism, as teacher performance is closely tied to student results in high-stakes exams **('Sharma & Chattopadhyay, 2021').** While conventional pedagogy provides a sense of order and control in resource-scarce settings, it curtails opportunities for deeper cognitive engagement and weakens the cultivation of scientific temper—a stated priority in national education policy **(Ministry of Education, 2020).**

### 5.2 The Partial and Uneven Adoption of 'Inquiry-Based Science Education (IBSE)': Policy Support but Weak Classroom Penetration

Although policy frameworks such as the '*National Curriculum Framework (2005)'* and the '*National Education Policy (2020)'* strongly endorse Inquiry-Based Science Education (IBSE). However, the approach

has yet to become a routine feature of classroom practice in Delhi's government schools. Despite efforts to promote inquiry based science teaching through initiatives like STEM clubs and science fairs, the daily rhythm of teaching continues to be shaped by traditional, lecture and textbook based methods.

IBSE is a tool to develop problem-solving skills and a deeper conceptual understanding because it encourages the students to ask questions, conduct experiments and create their own explanations. However, there are a lot of barriers to implement it in the classrooms of Delhi. Due to insufficient preparation and limited professional training, many teachers perceive 'Inquiry Based Science Education' as an "add-on" activity rather than an integral pedagogical approach. The scope for hands-on experiment is further constrained by the pressure to complete extensive syllabus within tight timelines. Similarly practical difficulties of managing open-ended tasks in overcrowded classrooms with inadequate infrastructure and resources further discourage to adopt it. Due to this, inquiry-based practices are generally limited to sporadic occasions of fairs or exhibitions rather than being incorporated into regular teaching of classrooms. At last, the systemic barriers preventing 'Inquiry Based Science Education' from becoming a standard practice have not been addressed by new teaching tools of ICT and AI like digital simulations and smart boards. Thus, 'Inquiry Based Science Education' remains more of an aspirational ideal than an operational reality in Delhi government schools.

### 5.3 Reforms in Delhi Education: Impact on Science Pedagogy:

Since 2015, Education system of government of NCT of Delhi has undergone through many reforms aimed to improve learning outcomes and accountability. *Mission Chunauti (2016)* introduced learning-level grouping, while *Mission Buniyaad* prioritised foundational literacy and numeracy (Banerjee et al., 2020). Though not subject-specific, these reforms influence science education indirectly. Stronger literacy and numeracy skills improve students' ability to comprehend scientific concepts, especially those requiring abstract reasoning and mathematical application (Banerji & Chavan, 2016).

Digital interventions—such as tablets, online platforms and interactive simulations—have enabled visualisation of scientific processes that are otherwise difficult to demonstrate in poorly equipped laboratories (Raina, 2021). However, the extent of reform impact is uneven. Teachers often use digital tools in passive ways, such as showing videos, without embedding them into inquiry-led activities (Sharma & Chattopadhyay, 2021). Evidence also suggests that while reforms enhance engagement in early grades, their translation into subject-specific pedagogy, particularly science, remains partial and inconsistent.

### 5.4 Systemic Constraints: The Invisible Hand Influencing Pedagogy

The most consistent theme across the literature is the role of systemic constraints in limiting pedagogical transformation.

- **Teacher training and capacity:** Many science teachers lack specialised training in inquiry-based methods. Pre-service programmes provide little exposure to laboratory-based pedagogy or formative assessment strategies, while in-service professional development is irregular, generic and poorly aligned with classroom realities (Batra, 2009). Continuous mentoring—essential for shifting towards IBSE—is missing. Collaborative models like teacher learning communities could help, but remain underdeveloped ('Preminger et al., 2024').

- **Infrastructure:** Laboratories in several schools are under-equipped or non-functional, particularly at the middle-school level. Even when digital tools are available, they are often poorly maintained, shared between classes, or used for administrative purposes (Yadav, 2018; Kumar & Srivastava, 2024).
- **Curriculum and assessment pressures:** The CBSE curriculum's content-heavy approach, coupled with exam-focused evaluation, leaves little scope for inquiry. Teachers prioritise syllabus completion and exam readiness over exploration. Frequent policy changes and administrative tasks further overwhelm teachers, reducing autonomy ('Rampal, 2001; Preminger et al., 2024').
- **Class size and heterogeneity:** Large, mixed-ability classrooms make it logistically challenging to conduct projects, discussions, or inquiry-based activities ('Sharma & Chattopadhyay, 2021').
- **Culture of limited autonomy:** In many schools, innovation is perceived as risky. Teachers' work is bound by rigid timetables, hierarchical supervision and performance indicators tied to exam outcomes. This culture discourages risk-taking and experimentation, both central to IBSE (Batra, 2005).

These findings highlight that classroom practices are not shaped by teachers alone but by broader systemic structures—including policy design, infrastructure provision, institutional culture and socioeconomic contexts. Any meaningful shift towards IBSE will therefore require reform not just at the pedagogical level but across the entire ecosystem of science education.

## 6. Conclusion:

Teaching of science education in Delhi's government schools is caught in a paradox. On the one side, policy frameworks such as the 'National Curriculum Framework (2005)' and the 'National Education Policy (2020)' envision science classrooms alive with hands on experiments, questioning and inquiry by the students. On the other side, the everyday reality remains dominated by textbooks, lectures based and exam oriented. The vision for science learning is modern and progressive, but classrooms practices are largely conventional and traditional.

Three main forces continue to anchor science teaching in paradox of conventional learning: a). Rigid lesson plans tied to textbooks, b). Overwhelming pressure of board examinations and c). Institutional resistance to pedagogical change by teachers. As a result, the aspiration for 'inquiry-driven learning' rarely translates into actual classroom practice. Teachers still rely heavily on rote methods of memorisations and performance indicators overshadows the cultivation of conceptual understanding and critical thinking in science teaching. Although initiatives such as 'Mission Chunauti', 'Mission Buniyaad', digital classrooms and science fairs have been launched since 2015, they have yet to transform pedagogy in any significant way. Overcrowded classrooms, under-equipped laboratories and insufficient teacher training remain formidable barriers. Teachers are often expected to innovate, but without the systemic support necessary for such innovation to succeed.

Nevertheless, the last decade of reforms has initiated valuable conversations on pedagogy, assessment and classroom culture. The introduction of technology, renewed emphasis on foundational learning, and student-

oriented approaches mark important steps toward change. Yet the challenge remains: how can these reforms penetrate the everyday reality of teaching science?

To move forward, three shifts are critical:

- Assessment reform that values questioning, reasoning, and experimentation.
- Teachers' professional development designed specifically for teaching science in engaging ways.
- Professional autonomy for teachers, allowing them to adapt lessons to students' needs.

Science education in Delhi government schools will transform only when curriculum, assessment, teacher development and classroom culture are integrated into a coherent vision of policies. Beyond programs and tools, what is needed is a system where exploration replaces memorization and where schools embody the spirit of scientific inquiry and temperaments. Only then, Delhi's government schools can nurture students who not only learn science but live it—through curiosity, imagination and discovery.

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