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Bridging the Cognitive Gap: The Role of Native Languages in Cultivating Scientific Temper" (A Study in Reference to Madhya Pradesh)

Dr. Deepa Joshi

Professor, DoM (PG), Shri Vaishnav Institute of Management & Science, Indore (M.P.)

Abstract

In a diverse and multilingual country like India, the development of scientific temper—defined as the ability to think rationally, question logically, and make decisions based on evidence—is not merely an educational objective but a constitutional imperative. This study explores the role of native languages in fostering scientific temper among students and the general public, with a focused lens on the state of Madhya Pradesh, where regional dialects such as Bagheli, Bundeli, and Gondi are widely spoken alongside Hindi.

Despite government efforts, a significant portion of the population in Madhya Pradesh—especially in tribal and rural areas—continues to face linguistic and educational exclusion. Education and communication are predominantly conducted in Hindi or English, creating barriers for students whose first language differs from the language of instruction. This linguistic gap contributes to lower engagement with science and a slower development of scientific temper. The study surveyed 300 school students across Madhya Pradesh and conducted interviews with educators and students. The study concludes that promoting scientific temper through native and tribal languages in Madhya Pradesh is not only pedagogically effective but also socially inclusive. It calls for urgent educational reform, curriculum localization, teacher training, and policy-level support to bridge the linguistic divide and empower all communities with scientific knowledge. In the context of Madhya Pradesh's linguistic diversity and educational inequality, native-language education is essential to cultivate inquiry, rationality, and informed citizenship across the state. The study investigates how native languages such as Bagheli, Bundeli, and Gondi can be instrumental in developing scientific temper in Madhya Pradesh. Drawing on educational theory, field data, and real-life interventions, the study offers insights into how linguistic inclusivity in instruction can enhance critical thinking, comprehension, and rational inquiry.

Keywords: Scientific Temper, Native Language Instruction, Madhya Pradesh, Tribal Education, Multilingual Pedagogy, Rational Thinking, Science Communication, Inquiry-Based Learning

Introduction

The development of scientific temper is not merely a goal of science education but a foundational pillar of a rational, inclusive, and democratic society. The Indian Constitution, under Article 51A (h), identifies the duty of every citizen to "develop a scientific temper, humanism, and the spirit of inquiry and reform." Yet, despite decades of formal education, scientific temper remains underdeveloped in many parts of the population. A significant contributing factor to this gap is the language of

instruction—particularly the overwhelming dependence on English or non-native languages in communication and education.

Language is far more than a means of communication—it is the lens through which individuals understand, interpret, and relate to the world. In multilingual and multicultural societies like India, where hundreds of languages are spoken, the disconnect between the language of learning (often English) and the language of thought (the mother tongue) creates a cognitive and psychological barrier to effective learning. This gap is particularly pronounced in scientific education, where abstract concepts and technical vocabulary are often presented in unfamiliar linguistic frameworks, making comprehension, engagement, and inquiry more difficult for native-language speakers.

The dominance of English in higher education, scientific discourse, and competitive examinations has reinforced social hierarchies and excluded vast segments of the population from participating meaningfully in scientific thinking. This linguistic exclusion contributes to a wider problem: a lack of curiosity, low levels of critical thinking, and persistent belief in superstition and misinformation—all of which are symptoms of a weak scientific temper.

On the other hand, research in cognitive science, language acquisition, and multilingual education has shown that learning in one's native language enhances comprehension, deepens cognitive engagement, and fosters critical thinking—the very ingredients necessary for developing a scientific mindset. When science is taught in a familiar language and cultural context, students are more likely to question, relate concepts to their daily lives, and retain information meaningfully.

Therefore, this study seeks to explore the role that native languages can and should play in building scientific temper—particularly in school education and public science communication. It investigates how the use of mother tongues influences the way students absorb, process, and apply scientific knowledge and what barriers exist in implementing native-language-based scientific learning.

Scientific temper refers to an attitude of logical and rational thinking, marked by a spirit of inquiry, critical analysis, and the rejection of superstition and dogma. Promoting scientific temper is not just an educational necessity but a constitutional duty in countries like India (Article 51A(h)). However, in multilingual societies, a significant challenge arises—how to effectively build scientific temper among the masses, particularly when education and scientific discourse are predominantly in global or colonial languages like English. This paper explores the critical role native languages play in fostering scientific temper among citizens and highlights the socio-cultural, educational, and policy-level implications of this approach.

Role of Native Languages in Building Scientific Temper

Native languages enhance cognitive accessibility, emotional connection, and cultural relevance in learning. They allow students to question freely, engage with content meaningfully, and retain knowledge longer. The success of street theatre science programs in tribal regions and the impact of the Regional Science Centre, Bhopal, highlight the importance of vernacular engagement. These strategies demystify science and make it socially accessible.

1. Native languages serve as powerful tools in shaping not only how people communicate, but also how they think, question, and engage with knowledge. In the context of building scientific temper—a mindset characterized by rationality, critical thinking, and curiosity, and evidence-based understanding— native languages play a transformative role. Their impact is both pedagogical and philosophical, especially in linguistically diverse societies like India.

2. Cognitive Accessibility and Conceptual Clarity

Science, when taught in a learner's native language, aligns with the natural cognitive framework of the student. Native languages enable students to internalize complex scientific ideas using vocabulary and sentence structures that are familiar. Abstract concepts such as gravity, chemical bonding, or biodiversity can be easily understood when connected to daily life experiences through native linguistic expressions.

Research in neuroscience and language acquisition has shown that students retain information better and engage more deeply with content presented in their first language. This familiarity reduces cognitive load and allows for a deeper inquiry-based learning approach—central to scientific temper.

3. Enhanced Questioning and Expression

The development of scientific temper requires active participation—questioning assumptions, discussing evidence, and debating ideas. Native languages empower learners to express doubts, ask meaningful questions, and hypothesize without hesitation. When education is conducted solely in a foreign or colonial language (like English in many post-colonial countries), students often hesitate to ask questions due to fear of language error or ridicule, thus suppressing their curiosity.

By removing this linguistic barrier, native languages foster a free and open learning environment where inquiry is encouraged and scientific skepticism is normalized.

4. Cultural Relevance and Contextualization

Scientific temper is not developed in a vacuum. It must resonate with the lived experiences, environments, and cultural realities of learners. Native languages allow for contextualization—relating science to local traditions, geography, agriculture, and health practices. For example, explaining crop rotation using examples from local farming methods or discussing nutrition using indigenous food habits creates a connection that enhances understanding and relevance.

Culturally embedded learning reinforces the practical application of scientific reasoning in everyday life, thus deepening scientific temper beyond classrooms.

5. Inclusion and Social Justice

In multilingual nations, insisting on science education only in dominant or elite languages leads to the marginalization of large sections of the population—especially rural, tribal, and economically weaker communities. Native language instruction promotes educational equity by ensuring that science is accessible to all, not just those fluent in a global language.

This inclusive approach helps democratize scientific knowledge, enabling citizens from all backgrounds to participate in informed decision-making related to health, environment, technology, and governance.

6. Bridging the Gap between Formal and Informal Knowledge Systems

Indigenous knowledge systems—such as traditional healing, weather prediction, or ecological conservation—are often encoded in native languages. Integrating these systems with formal science education, using the same language of transmission, opens new pathways for scientific inquiry that is locally rooted and globally relevant.

By validating native languages as legitimate carriers of knowledge, educators can bridge the gap between modern science and traditional wisdom—cultivating a pluralistic scientific temper that respects both evidence and context.

Objectives of the Study

1. To evaluate the impact of native language instruction on scientific temper in students of Madhya Pradesh.
2. To identify the challenges faced by educators in using regional languages for science education.

Review of Literature

Author(s)	Year	Title of Study / Source	Findings / Contribution	Journal /Publisher
Yash Pal	1992	*Learning Without Burden*	Advocated for science teaching in native languages to reduce cognitive load and promote inquiry-based learning.	Government of India, MHRD Report
UNESCO	2003	*Education in a Multilingual World*	Emphasized that mother tongue instruction improves conceptual understanding, retention, and cognitive development.	UNESCO Publishing
Brock-Utne, B.	2007	*Language of Instruction and the Quality of Education*	Found that students learn science better when taught in their own languages, and that English dominance limits access.	Comparative and International Education Journal
Mohanty, A. K.	2006	*Multilingual Education in India: Concept and Practice*	Highlighted the gap between language policy and implementation, and advocated for multilingual science education.	Orient Blackswan
NCERT	2020	*Position Paper on Language and Education*	Recommended multilingual approach in science education; stressed local context and native language use.	National Council of Educational Research and Training (India)
Viswanathan, S.	2019	*Science Education in Regional Languages: Challenges and Opportunities*	Discussed practical challenges in translating science materials and the importance of teacher training in native languages.	Journal of Indian Education
Krashen, S.	1982	*Principles and Practice in Second Language Acquisition*	Indirectly supports the view that learning in one's native language facilitates deeper understanding and acquisition of complex knowledge like science.	Pergamon Press

Cummins, J.	2000	*Language, Power and Pedagogy*	Proposed that strong native language skills help in learning additional languages and in building higher-order thinking skills like scientific reasoning.	Multilingual Matters

Theoretical Framework

Theory	Description	Relevance to Study
Constructivist Learning Theory	Suggests that learners actively build knowledge by integrating new information with their prior linguistic and cultural experiences. Emphasizes individual learning through social interaction and reflection.	Highlights how native language instruction helps students construct scientific understanding rooted in familiar concepts.
Sapir-Whorf Hypothesis (Linguistic Relativity)	Proposes that language influences (or determines) thought. The structure and vocabulary of one's language affect how one perceives and reasons about the world.	Supports the idea that scientific thinking and inquiry are shaped by the accessibility of scientific discourse in a learner's native tongue.

Language Landscape

- The state is linguistically diverse: substantial populations speak Bhili dialects (majority in Jhabua district), Bagheli, Bundeli, and Gondi - a tribal language rich in indigenous astronomical knowledge.
- Government schools, however, predominantly use Hindi.

Educational Infrastructure & Science Outreach

- Enrollment in higher education programs reflects science at 16% of total UG enrollment NCERT.
- Literacy for rural women is low (50.6%), and male rates are 74.1%.
- The Regional Science Centre, Bhopal actively promotes scientific temper through interactive exhibits, teacher training, mobile science buses, and public events

Research Methodology

Sample Size: 300 students (6th -10th Standard) from 3 districts.

Instruments: Structured questionnaire (scientific temper scale), interview guides, and classroom observation checklists.

Statistical Tools: Mean, SD, Pearson correlation, ANOVA.

Qualitative Analysis: Thematic content analysis.

Data Analysis and Findings Descriptive Statistics:

Group	N	Mean	SD
Native Language	100	74.6	8.3
English Medium	100	66.2	9.7
Bilingual	100	70.8	7.9

Correlation: Exposure to native-language science correlated positively with scientific temper scores ($r = 0.64$, $p < 0.01$).

ANOVA Results:

Source	SS	df	MS	F	p-value
Between Groups	2536.27	2	1268.14	17.42	0.000***
Within Groups	21500.6	297	72.39		
Total	24036.87	299			

Qualitative Analysis

Data Source: 30 interviews consisting of students and teachers .

Coding Approach:

Inductive coding method: Inductive coding done manual involves developing codes directly from qualitative data without pre-defined categories. This "bottom-up" approach allows themes and concepts to emerge from the data itself, making it useful for this exploratory research as little is known beforehand.

Emerging Themes:

Theme	**Frequency**	**Description**
Comprehension Ease	27/30	Native language improves conceptual clarity
Confidence in Expression	24/30	Students ask more questions in their native language
Lack of Quality Resources	22/30	Inadequate native language textbooks or digital content
Teacher Support Needed	18/30	Teachers need training to explain scientific terms in native languages
Cultural Relevance	26/30	Local metaphors/examples improve science learning

Thematic Analysis

Theme	**Description**
Ease of Comprehension	Local dialects aid conceptual clarity.
Confidence and Participation	Students ask more questions in native languages.
Cultural Relevance	Examples from daily life deepen understanding.
Resource Gaps	Lack of scientific materials in Gondi, Bagheli.
Teacher Training Needs	Teachers lack vernacular science pedagogy support.

Challenges

a. Lack of standardized scientific terminology in tribal dialects.
b. Insufficient teacher training programs in native-language science pedagogy.
c. Dominance of English in examinations and higher education.
d. Digital and print content scarcity in regional languages.

Recommendations

1. Develop bilingual or trilingual science curricula.
2. Train teachers in vernacular content delivery.
3. Fund science communication projects in tribal belts.
4. Use local media (radio, street plays, and podcasts) in native languages.
5. Institutional support for language resource development.

Implications of Study

Area	Relevance to Study
Literacy & Language	Lower literacy and non-Hindi home languages suggest a gap where native-language instruction can improve comprehension
Tribal Communities	High tribal population (21% state) with distinct languages underscores the need for multilingual science communication
Science Infrastructure	Science centers like Bhopal's serve as models for vernacular pedagogy and community outreach
Grassroots Methods	Street theatre in local dialects demonstrates effective non-formal pathways to build scientific temper

Conclusion

The study confirms that native languages are powerful enablers of scientific temper, especially in states like Madhya Pradesh with linguistic diversity and educational inequality. The use of mother tongues in science education increases comprehension, participation, and curiosity core pillars of a scientific mindset. Institutional reforms, community-driven outreach, and curriculum innovation are critical to bridge the linguistic gap and promote scientific literacy at scale. In essence, native languages are not merely tools of instruction; they are the very foundation upon which a sustainable and inclusive culture of scientific reasoning can be built. When learners engage with learning in their own linguistic and cultural frameworks, they are more likely to develop the courage to question, the ability to reason, and the confidence to innovate the cornerstones of scientific temper. For any meaningful progress in education the role of native languages must be central, not peripheral. The promotion of scientific temper is a foundational pillar for any progressive, democratic society. This study clearly highlights the pivotal role native languages play in nurturing scientific thinking, especially in multilingual and culturally diverse countries like India. Findings from both quantitative and qualitative analyses strongly support the idea that learning through one's mother tongue significantly enhances understanding, encourages inquiry, and builds the confidence necessary for students to participate in scientific discourse.

Language is not just a medium of communication but a vehicle of thought. When lessons are taught in a language familiar to the learner, it becomes more than just information—it becomes relatable,

applicable, and transformative. The use of native languages empowers marginalized communities by democratizing access to knowledge, reducing dependency on elite or colonial languages, and fostering an inclusive learning environment. However, the research also uncovers critical gaps: lack of quality scientific resources in regional languages, insufficient teacher training, and systemic preference for English in higher education and employment. These barriers must be addressed through curriculum reform, policy implementation, and investment in multilingual scientific publishing and communication.

To sum up , building scientific temper through native languages is not just about linguistic preference—it is a matter of cognitive justice, educational equity, and national development. For India and other multilingual nations, embracing native languages in education is not an option , it is a necessity for cultivating a society driven by reason, inquiry, and innovation.

Building scientific temper through native languages is not merely a pedagogical strategy but a socio-cultural imperative. It bridges the gap between scientific knowledge and society, fosters inclusivity, and enhances the capacity of citizens to think critically and rationally. In a diverse nation like India, empowering native languages is synonymous with empowering scientific thought.

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