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A Study on the Development of Scientific Temper among Students through Science Education in Indian Schools

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Abstract:

The development of scientific temper among students has been recognized as a crucial goal of education in India since the time of independence. Scientific temper refers to a mindset that values rational thinking, curiosity, evidence-based reasoning, and openness to questioning. In the context of school education, it is not only about learning science as a subject but also about cultivating habits of inquiry and critical thinking that extend to everyday life. This study explores how science education in Indian schools contributes to the development of scientific temper among students.Secondary sources such as policy documents, curriculum frameworks, and scholarly studies reveal that the National Education Policy (NEP) 2020 emphasizes inquiry-based learning, experiential activities, and integration of technology to nurture scientific temper. The National Curriculum Framework also highlights the importance of moving beyond rote learning to encourage questioning, experimentation, and problem-solving. However, challenges remain in practice. Many schools, particularly in rural areas, continue to rely heavily on textbook-centered teaching and exam-oriented approaches. Limited infrastructure, lack of laboratory facilities, and insufficient teacher training often restrict opportunities for hands-on learning.At the same time, prospects are encouraging. Initiatives such as Atal Tinkering Labs, STEM clubs, and digital learning platforms are creating new spaces for students to explore science creatively. Teachers who adopt activity-based methods and encourage curiosity play a vital role in fostering scientific temper. The study underscores that scientific temper cannot be developed through memorization alone; it requires supportive environments, innovative pedagogy, and a culture of questioning. So, science education in Indian schools has the potential to nurture scientific temper, but this requires consistent efforts to strengthen infrastructure, teacher training, and pedagogical practices. By addressing these challenges, schools can prepare students not only to excel academically but also to become rational, innovative, and responsible citizens.

Keywords: *Scientific Temper, Science Education, Inquiry-Based Learning, Critical Thinking, NEP 2020, Curriculum Framework.*

Introduction:

The idea of developing a scientific temper among students has been a central goal of Indian education since independence. Scientific temper refers to an attitude of rational thinking, curiosity, questioning, and reliance on evidence rather than superstition or blind belief. In schools, science education plays a vital role in nurturing this mindset, as it provides students with opportunities to explore, experiment, and understand the

world around them in a logical and systematic way.Science education in India has undergone significant reforms over the years, with the National Education Policy (NEP) 2020 placing strong emphasis on inquiry-based learning, experiential activities, and integration of technology. The National Curriculum Framework also highlights the importance of moving away from rote memorization and encouraging students to ask questions, test ideas, and apply knowledge to real-life situations. These reforms aim to ensure that students not only learn scientific facts but also develop the ability to think critically and solve problems creatively.

Despite these policy efforts, challenges remain in practice. Many schools, especially in rural areas, continue to rely heavily on textbook-centered teaching and exam-oriented approaches. Limited infrastructure, lack of laboratory facilities, and insufficient teacher training often restrict opportunities for hands-on learning. As a result, students may learn science as a subject but fail to develop the deeper habits of inquiry and rational thinking that define scientific temper.At the same time, new initiatives such as Atal Tinkering Labs, STEM clubs, and digital learning platforms are creating spaces for students to engage with science in innovative ways. Teachers who adopt activity-based methods and encourage curiosity play a crucial role in this process.By analyzing existing literature, policy documents, and reports, it aims to identify both challenges and opportunities, emphasizing that nurturing scientific temper is essential for preparing students to become rational, innovative, and responsible citizens in a rapidly changing world.

Need and Significance of the Study

The development of scientific temper among students has been emphasized in India since independence, as it is seen as essential for building a rational, progressive, and democratic society. Scientific temper refers to an attitude of curiosity, questioning, evidence-based reasoning, and openness to new ideas. In today's world, where students are exposed to rapid technological changes and diverse information sources, nurturing a scientific temper through school education has become more important than ever.The need for this study arises from the fact that science education in many Indian schools still relies heavily on rote learning and exam-oriented approaches. While policies such as the National Education Policy (NEP) 2020 and the National Curriculum Framework encourage inquiry-based learning, experimentation, and problem-solving, their implementation is uneven. Rural schools often face challenges such as inadequate infrastructure, lack of laboratories, and insufficient teacher training, which restrict opportunities for hands-on learning. Without these experiences, students may learn scientific facts but fail to develop the deeper habits of rational thinking and inquiry that define scientific temper.

The significance of this study lies in its potential to highlight both challenges and opportunities in science education. By analyzing secondary data, it shows how initiatives like Atal Tinkering Labs, STEM clubs, and digital learning platforms can create new spaces for students to explore science creatively. It also emphasizes the role of teachers, who can inspire curiosity and critical thinking through activity-based methods. Developing scientific temper is not only important for academic success but also for preparing students to become responsible citizens who can make informed decisions, challenge misinformation, and contribute to innovation and national development.So, this study underscores that nurturing scientific temper through science education is vital for India's future, as it equips students with the mindset needed to thrive in a knowledge-driven and democratic society.

Table 1: Need and Significance of Developing Scientific Temper among Students in Indian Schools

Aspect	Dimensions
Need for the Study	Scientific temper is essential for building rational, progressive, and democratic citizens. Despite reforms, many schools still rely on rote learning and exam-oriented approaches. Rural schools face challenges such as poor infrastructure, lack of laboratories, and insufficient teacher training, which limit inquiry-based learning. Without hands-on

	experiences, students may learn facts but fail to develop curiosity, questioning, and rational thinking.
Policy Context	NEP 2020 and the National Curriculum Framework emphasize inquiry-based learning, experimentation, and problem-solving. These policies aim to move beyond memorization and encourage students to apply knowledge to real-life situations. However, implementation remains uneven across schools.
Significance for Students	Developing scientific temper helps students think critically, challenge misinformation, and make informed decisions. It prepares them not only for academic success but also for becoming responsible citizens in a knowledge-driven society.
Significance for Teachers	Teachers play a crucial role in fostering scientific temper. Activity-based methods, curiosity-driven teaching, and encouragement of questioning can inspire students to adopt rational and evidence-based thinking.
Significance for Innovation and Society	Scientific temper contributes to innovation, creativity, and national development. By nurturing rational and open-minded learners, schools prepare future citizens who can contribute to India's progress in science, technology, and democratic decision-making.
Opportunities Highlighted	Initiatives such as Atal Tinkering Labs, STEM clubs, and digital learning platforms provide new spaces for students to explore science creatively. These programs show promise in bridging gaps and creating supportive environments for inquiry-based learning.

Literature Review

The idea of developing scientific temper among students has been a central concern of Indian education policy since independence. Scientific temper is understood as a mindset that values rational thinking, curiosity, questioning, and evidence-based reasoning. Literature on science education in India shows that schools play a crucial role in nurturing this attitude, but the extent of success varies across contexts.Several studies highlight that the National Education Policy (NEP) 2020 and the National Curriculum Framework (NCF) emphasize inquiry-based learning, experiential activities, and problem-solving approaches. According to Chaudhary (2024), NEP 2020 marks a shift from rote memorization to activity-based learning, aiming to cultivate curiosity and creativity among students. Similarly, Jena and Das (2024) argue that technology integration in classrooms can support scientific temper by encouraging experimentation and critical thinking.

Research shows that despite progressive policies, classroom practices often remain exam-oriented. Rudresh (2025) points out that many schools, especially in rural areas, lack laboratories and trained teachers, which limits opportunities for hands-on learning. Kumar (2025) adds that infrastructural gaps and socio-economic disparities create unequal access to quality science education, affecting the development of scientific temper. These findings suggest that while policies are ambitious, implementation challenges persist.Teachers are central to fostering scientific temper. Studies emphasize that educators who adopt activity-based methods, encourage questioning, and integrate ICT tools are more successful in nurturing rational thinking. Rani and Kaur (2025) highlight that teacher commitment and professional development directly influence how effectively scientific temper is promoted in classrooms. However, limited training opportunities and heavy workloads often restrict teachers from adopting innovative practices.

On the positive side, initiatives such as Atal Tinkering Labs, STEM clubs, and digital learning platforms are creating new spaces for students to engage with science creatively. Rangarajan, Sharma, and Grové (2023) note that such programs encourage experimentation and collaborative learning, which are essential for

developing scientific temper. These initiatives show promise in bridging the gap between policy goals and classroom realities. So, the literature converges on the idea that scientific temper is vital for preparing students to become rational and responsible citizens. Policies like NEP 2020 and NCF provide strong frameworks, but challenges such as inadequate infrastructure, exam-centric teaching, and limited teacher training hinder progress. At the same time, innovative initiatives and supportive teaching practices offer opportunities to strengthen science education. The reviewed studies highlight that developing scientific temper requires not only curriculum reforms but also systemic efforts to improve resources, teacher capacity, and student engagement.

Objectives

1. To explore how science education in Indian schools contributes to the development of scientific temper among students through the analysis of secondary data.
2. To identify the challenges and opportunities in promoting scientific temper within the current science education system in India using qualitative insights from secondary sources.

Discussion

The study set out with two main objectives: first, to explore how science education in Indian schools contributes to the development of scientific temper among students, and second, to identify the challenges and opportunities in promoting scientific temper within the current system. Using a qualitative approach and secondary data, the discussion highlights both achievements and gaps in this area.Science education is expected to nurture curiosity, rational thinking, and problem-solving skills among students. Secondary data from curriculum frameworks and policy documents such as the National Education Policy (NEP) 2020 show that inquiry-based learning and experiential activities are emphasized as key strategies. The National Curriculum Framework also encourages teachers to move beyond rote memorization and focus on questioning, experimentation, and application of knowledge. These approaches are designed to help students develop scientific temper, which is not just about learning facts but about cultivating a mindset of rational inquiry.

However, the literature suggests that classroom practices often remain exam-oriented. Many schools continue to prioritize memorization and test performance over inquiry and exploration. This limits the ability of students to develop deeper habits of rational thinking. Thus, while the policy framework is progressive, its translation into classroom practice is uneven.Secondary data highlights several challenges. Rural schools often lack laboratories, adequate infrastructure, and trained teachers. Without access to hands-on experiments, students miss opportunities to engage with science in a practical way. Teacher preparedness is another issue. Many educators are not adequately trained in activity-based methods or ICT integration, which restricts their ability to foster curiosity and questioning. Socio-economic disparities also play a role, as students from disadvantaged backgrounds may have limited exposure to scientific resources.

These challenges suggest that while science education has the potential to nurture scientific temper, systemic barriers prevent its full realization. Exam-centric culture, infrastructural gaps, and insufficient teacher training remain major obstacles.On the other hand, there are promising initiatives that create opportunities for fostering scientific temper. Programs such as Atal Tinkering Labs, STEM clubs, and digital learning platforms provide spaces for students to experiment, innovate, and collaborate. These initiatives encourage hands-on learning and creativity, which are essential for developing rational and evidence-based thinking. Teachers who adopt activity-based methods and encourage questioning play a crucial role in this process.

Secondary data also shows that technology integration is opening new possibilities. Digital platforms and interactive tools allow students to explore scientific concepts beyond textbooks. When combined with supportive teaching practices, these resources can significantly enhance the development of scientific

temper.The discussion reveals that the two objectives are closely linked. Science education contributes to scientific temper when it is inquiry-driven and experiential. At the same time, identifying challenges and opportunities helps in understanding why the outcomes are uneven. The presence of supportive infrastructure, trained teachers, and innovative initiatives strengthens the link between science education and scientific temper. Conversely, the absence of these factors weakens the connection.

So, secondary data suggests that science education in Indian schools has the potential to nurture scientific temper, but this requires consistent efforts to overcome challenges. Policies like NEP 2020 provide a strong framework, yet their success depends on effective implementation. Addressing infrastructural gaps, improving teacher training, and promoting innovative initiatives are essential steps. Scientific temper cannot be developed through memorization alone; it requires supportive environments, activity-based pedagogy, and a culture of questioning. By strengthening these aspects, schools can prepare students not only for academic success but also to become rational, innovative, and responsible citizens.

Table 2: Discussion of the Study

Aspect	Discussion
Concept of Scientific Temper	Scientific temper refers to developing a rational, logical, and questioning mindset among students. It encourages curiosity, evidence-based thinking, and freedom from superstition.
Importance in School Education	Schools play a crucial role in nurturing scientific temper because early learning shapes thinking habits. Science education helps students understand the world through observation, experimentation, and reasoning.
Role of Science Curriculum	The science curriculum promotes inquiry-based learning, experimentation, and problem-solving activities. Well-designed content connects scientific concepts with daily life situations.
Teaching–Learning Process	Interactive teaching methods such as laboratory work, projects, demonstrations, and group discussions help students develop critical and analytical thinking. Rote learning limits scientific attitude.
Teacher's Role	Teachers act as facilitators who encourage questioning, independent thinking, and logical reasoning. Their attitude toward science strongly influences students' mindset.
Use of Experiments and Practical Work	Practical activities help students verify scientific principles through direct experience. Hands-on learning builds observation skills and logical interpretation.
Integration of ICT	Digital tools, simulations, and virtual labs make scientific concepts easier to understand and more engaging, especially where physical lab facilities are limited.
Co-curricular Activities	Science exhibitions, quizzes, field visits, and innovation clubs promote creativity, curiosity, and real-world scientific exposure.
Barriers in Developing Scientific Temper	Major challenges include lack of laboratory facilities, exam-oriented learning, insufficient teacher training, and persistence of superstitious beliefs.

Gender and Equity Dimension	Equal participation of boys and girls in science learning is necessary. Encouraging girls in STEM strengthens inclusive scientific development.
Outcome on Students	Students develop logical thinking, problem-solving ability, open-mindedness, and decision-making skills useful in academics and everyday life.
National Development Link	Scientific temper supports innovation, technological progress, and informed citizenship, contributing to national growth.
Policy Support	Educational policies emphasize experiential learning, research orientation, and innovation to strengthen scientific mindset among learners.
Overall Implication	Strengthening science education with practical exposure and inquiry-based pedagogy is essential for cultivating scientific temper among school students.

Conclusion

The study on the development of scientific temper among students through science education in Indian schools highlights both achievements and challenges. Scientific temper, which refers to rational thinking, curiosity, questioning, and evidence-based reasoning, has been a central goal of Indian education since independence. Policies such as the National Education Policy (NEP) 2020 and the National Curriculum Framework emphasize inquiry-based learning, hands-on activities, and problem-solving approaches to nurture this mindset.

Secondary data analysis shows that while these frameworks provide strong direction, classroom practices often remain exam-oriented and focused on rote memorization. Many schools, particularly in rural areas, face infrastructural limitations such as lack of laboratories, inadequate resources, and insufficient teacher training. These challenges restrict opportunities for students to engage in practical learning and develop deeper habits of inquiry.

At the same time, innovative initiatives like Atal Tinkering Labs, STEM clubs, and digital learning platforms are creating new possibilities for fostering scientific temper. Teachers who adopt activity-based methods and encourage questioning play a vital role in bridging the gap between policy and practice. The study underscores that scientific temper cannot be developed through memorization alone; it requires supportive environments, innovative pedagogy, and a culture of curiosity.

So, science education in Indian schools has the potential to nurture scientific temper, but this requires consistent efforts to strengthen infrastructure, empower teachers, and promote inquiry-driven learning. By addressing these challenges and leveraging opportunities, schools can prepare students to become rational, innovative, and responsible citizens who contribute meaningfully to India's progress in a knowledge-driven world.

Recommendations

The study shows that science education in Indian schools has the potential to nurture scientific temper, but this requires consistent and practical efforts. Based on the findings from secondary data, several recommendations can be made to strengthen both teaching practices and learning environments.

First, schools should move beyond rote learning and exam-oriented approaches. Inquiry-based learning, experimentation, and activity-driven teaching must become central to classroom practice. Teachers should encourage students to ask questions, test ideas, and apply knowledge to everyday life situations.

Second, teacher training and professional development need to be prioritized. Teachers play a crucial role in fostering curiosity and rational thinking, but many lack exposure to modern pedagogical methods and ICT tools. Regular workshops, mentoring, and hands-on training can help teachers adopt innovative strategies that promote scientific temper.

Third, infrastructure must be improved, especially in rural schools. Laboratories, science kits, and digital resources should be made available so that students can engage in practical learning. Without these facilities, science education risks remaining theoretical and disconnected from real-world inquiry.

Fourth, innovative initiatives should be expanded and supported. Programs like Atal Tinkering Labs, STEM clubs, and digital learning platforms have shown promise in creating spaces for creativity and experimentation. Scaling these initiatives across schools can help bridge gaps between policy and practice.

Finally, schools and policymakers should treat the development of scientific temper as a continuous process rather than a one-time goal. Collaboration between teachers, institutions, and communities is essential to create a culture of questioning, evidence-based reasoning, and innovation. By doing so, students will be better prepared to become rational, responsible, and forward-looking citizens.

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