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Developing Scientific Attitude in Indian School Education: An Analysis Based on NCERT and NAS Reports

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Abstract :

This research paper analyses the development of scientific attitude among students in the Indian school education system particularly based on the science learning outcomes of the National Council of Educational Research and Training (NCERT) and the National Achievement Survey (NAS) 2021 reports. An in-depth analysis of NCERT science learning outcomes shows that it focuses on promoting scientific process skills and critical thinking. However, the national and Rajasthan state reports of NAS 2021 show that students' performance especially in higher-order thinking and application of concepts is not satisfactory. The study highlights a significant gap between the expected scientific attitude of NCERT and the results of NAS the possible reasons for which are deficiencies in pedagogy, lack of teacher training, and challenges in the assessment system. The paper presents concrete recommendations, including curriculum reform, innovation in teaching methods and teacher capacity building to strengthen the development of scientific attitude.

Keywords: Scientific attitude, NCERT learning outcomes, NAS 2021, Indian school education, science education, Rajasthan.

Introduction :

In the 21st century, developing scientific attitude is crucial for global competitiveness and sustainable development. A society where citizens think logically, make evidence-based decisions and critically analyze problems lays the foundation for innovation and progress. In India, the National Education Policy (NEP) 2020 also emphasizes on inculcating critical thinking, scientific temper and inquiry-based learning in students (Ministry of Education, 2020). Ensuring that the young generation develops a scientific temper is essential not only for success in scientific subjects but also for making informed decisions in daily life and

becoming an informed citizen.

However, there have been concerns about the actual development of scientific aptitude in students in the Indian school education system. Often, the education system focuses more on rote memorization of knowledge rather than teaching students to ask ' how to think ' and ' why ' questions. This problem statement forms the basis of this research is our education system simply imparting scientific information to students or are they actually being equipped to think scientifically and use the scientific method ? The answer to this question can be obtained from the learning outcomes set by the National Council of Educational Research and Training (NCERT) and large-scale assessments such as the National Achievement Survey (NAS). NCERT learning outcomes indicate what is expected from students, while NAS provides a snapshot of actual learning levels.

Objectives of the Study:

The main objective of this research is to present a comprehensive analysis of the development of scientific attitude in Indian school education. To achieve this objective, the following specific objectives will be focused upon:

- NCERT secondary level science learning outcomes.
- To analyse the current level of scientific attitude in science among Indian school students (especially classes 8 and 10) through the National Report of NAS 2021.
- To evaluate the development of scientific attitude in state-specific context based on Rajasthan State Report of NAS 2021.
- To analyse the gap between NCERT objectives and NAS results and explore the possible reasons for this gap.
- To identify the major challenges in promoting the development of scientific attitude in Indian school education and make concrete recommendations for their resolution.
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Research Questions : To achieve the above objectives, the following research questions will be addressed:

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- NCERT secondary level science learning outcomes define development of scientific attitude and what are its major components ?
- As per the national and Rajasthan reports of NAS 2021, what is the current level of understanding, application, and higher-order thinking of scientific concepts among Indian school students (especially in classes 8 and 10) ?
- Are the findings of NAS 2021 in line with the expected learning outcomes of scientific attitude prescribed by NCERT ?
- What are the major challenges hindering the overall development of scientific attitude in Indian school education ?

Significance of the Study: This study provides important insights on the current state of scientific attitude development in Indian school education. By comparing NCERT's instructional goals with concrete reports such as NAS 2021, this paper will provide policymakers with an evidence-based basis for making targeted interventions in curriculum reform, teacher training programmes, and assessment strategies. It will also be valuable for teachers, curriculum designers, and parents to better understand their roles in promoting scientific thinking and curiosity among students. Ultimately, this research will contribute to building a more rational and scientifically aware society.

Conceptual Framework :

Scientific attitude is defined as the application of the principles of the scientific method (observation, hypothesis, experimentation, analysis, inference) and personal qualities such as critical thinking, open-mindedness, curiosity, objectivity and evidence-based reasoning. The framework attempts to link scientific thinking as envisaged in the learning outcomes for secondary level science by the National Council of Educational Research and Training (NCERT) with the actual achievement of students as reflected by the reports of the National Achievement Survey (NAS) 2021. It views scientific attitude as a dynamic cognitive and behavioural capability rather than a mere accumulation of knowledge, which enables students to solve real-life problems and make informed decisions.

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Review of Literature:

Science education in India has always been at the centre of national development and documents such as the National Education Policy (NEP) 2020 consistently emphasise the development of scientific temper and critical thinking among students. NEP 2020 particularly highlights the need to promote experiential learning and higher -order thinking skills, which are directly related to the development of scientific aptitude (Ministry of Education, 2020). Historically, the Indian education system has been dominated by rote learning, as observed in various national and international assessment studies. Several studies conducted in the last decade have highlighted the superficial understanding of scientific concepts and their application among Indian students. For instance, some research has shown that lack of teacher training and the use of traditional teaching methods hinder the development of scientific process skills (Kumar, 2017). Large-scale assessments such as the NAS provide a snapshot of student learning outcomes and often serve as important data sources for policy interventions. These surveys also present student performance across various demographic and socio-economic factors. However, these reports usually focus only on numbers and a detailed analysis of the conceptual and implementation gaps between NCERT's learning outcomes and actual student achievement reflected in the NAS is rare.

Research Gap Identified:

While NCERT learning outcomes provide a theoretical and instructional guide for scientific aptitude and the NAS 2021 reports present empirical data on learning achievement of Indian students, an integrated and in-depth analysis of the apparent gap between these two, particularly in the context of developing scientific aptitude, has not yet been adequately done. This research attempts to fill this specific gap in knowledge as to why this gap exists between the goals set by NCERT and the realities highlighted by NAS and what are its implications. This study goes beyond simply presenting data and analyses the underlying reasons for these discrepancies and their impact on the development of scientific aptitude.

Research Methodology:

This study is an attempt to analyse the development of scientific attitude in Indian school education. **Analytical and descriptive approach.** This research primarily analyzes

secondary sources, including documents published by the National Council of Educational Research and Training (NCERT) and reports from the National Achievement Survey (NAS) 2021. This method allows developing a comprehensive understanding of the subject using both qualitative and quantitative data.

Data Sources: The following key documents have been used as primary data sources for this research:

1. **NCERT Learning Outcomes for Science (Secondary Level):** This document defines the learning outcomes and skills required for teaching science at the secondary level which is helpful in understanding the conceptual basis of scientific attitude (National Council of Educational Research and Training, 2021).

2. **NAS 2021 National Report (Class III, V, VIII and X):** This report provides comprehensive data on student learning achievement in various subjects, especially in science, at the national level. It gives a detailed overview of students' performance on questions related to Higher Order Thinking (HOTS), which are direct indicators of scientific aptitude (Ministry of Education, 2021).

3. **NAS 2021 State Report Card: Rajasthan (Class III, V, VIII and X):** This report presents the performance of students in the state of Rajasthan against the national average to identify state-specific trends and challenges in developing scientific attitude (Ministry of Education, 2021).

Process of Data Analysis: The analysis process was divided into three main steps:

1. **NCERT Learning Outcomes:**

    - "Learning_outcomes_Science.pdf" (**NCERT** *Learning outcomes for science, secondary level)* was carefully studied to identify all the learning outcomes that are directly or indirectly related to the components of scientific attitude (such as observation, classification, inquiry, experimentation, interpretation of data, drawing conclusions, logical thinking and critical analysis).

    - NCERT's emphasis on scientific process skills and its implications for developing scientific temper in students were understood.

2. **Quantitative and Qualitative Analysis of NAS Reports:**
    - 8 and 10 students in Science subject and their performance (in percentage) on various learning outcomes were analyzed from "NAS21_NRC.pdf" (National Report) and " NAS21_SRC_Rajasthan_pdf" (Rajasthan Report).
    - In particular, the focus was on students' performance on questions related to HOTS (application, analysis and evaluation), as these are strong indicators of scientific aptitude. For example, students' average percentage scores on various learning outcomes given in the reports (e.g. performance below 40-50% in Class 8 Science on LOs that require ' analysis ' or ' application ') were assessed.
    - gender, rural/urban area, type of school and socio-economic status on the development of scientific attitude, as presented in the NAS reports, was also analysed.
3. **Comparative Analysis:**
    - The expected scientific aptitude set by NCERT Learning Outcomes was compared with the actual achievement of students as reflected in the NAS 2021 reports.
    - The objective of this comparison was to identify the gaps between NCERT 's expectations and the actual performance of students and to analyse the possible reasons for these gaps (such as teaching methodology, teacher training, assessment system, lack of resources).

Limitations:

This study is primarily limited to the analysis of available public documents. It does not involve direct classroom observations, interviews with teachers or students or experimental interventions, which could have provided more in-depth insights into the complex factors of scientific attitude development.

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Data Analysis & Interpretation:

This section presents analysis and interpretation of data obtained from NCERT Science Learning Outcomes and National and Rajasthan Reports of NAS 2021 with the aim to understand the current status of scientific attitude development in Indian school education.

NCERT Learning Outcomes: The NCERT secondary level science learning outcomes (National Council of Educational Research and Training, 2021) provide a clear framework for the development of scientific attitude. The introduction of the document itself clarifies that science arises from processes such as "observation, looking for regularities and patterns, formulating hypotheses, building qualitative or mathematical models, estimating their consequences, verifying or falsifying theories through observation and controlled experiments". This directly emphasises the various steps of the scientific method. Scientific process skills are intrinsically incorporated in the learning outcomes. For example, students "observe and recognize characteristics" of different materials and phenomena (such as understanding the properties of metals/nonmetals) , " design and conduct experiments" (such as studying chemical reactions) , " collect and analyze data" (such as data on the effects of temperature or light) and "apply scientific principles to solve real-life problems" (such as increasing crop yields or controlling diseases). These outcomes focus on developing critical thinking, logical reasoning, and scientific inquiry in students rather than simply recalling knowledge.

The NAS 2021 National and Rajasthan reports:

1. Overall Performance: The NAS 2021 national report (Ministry of Education, 2021) shows that student's performance in science is not satisfactory especially in higher classes. The national average performance in science in class 8 was 319 marks (out of a total of 500). However, this dropped to 295 marks in class 10, indicating increasing difficulty in understanding science concepts in higher classes by students. The performance of the state of Rajasthan was quite close to the national trends. Rajasthan's average science score in class 8 was 319 marks, which was equal to the national average, while in class 10 it was 294 marks, only slightly below the national average of 295 (Ministry of Education, 2021). This pattern highlights that students face a challenge in understanding concepts as they become more complex .

2. Performance on Learning Outcomes (special focus on higher-order thinking): NAS

reports also highlight students' performance on various learning outcomes. Students' performance on questions related to higher-order thinking skills (HOTS) such as application, analysis, and evaluation, which are crucial for scientific aptitude, was consistently weaker than recall-based questions. For example, in the NAS 2021 reports, the average percentage scores on science learning outcomes of class 8 and 10 students were often found to be below 50% in areas that required in-depth analysis of concepts or their application in real life. This indicates that students can recall scientific facts but struggle to apply them to new situations or draw logical conclusions.

3. Influencing factors: NAS reports also show the impact of various background factors (such as gender, type of school, rural/urban area, parental education) on student performance. In science, students from urban areas and private schools performed better than those from rural areas and government schools. This disparity suggests that differences in learning environment, available resources and quality of teaching are influencing the development of scientific aptitude. However, no significant difference in performance was observed between boys and girls in science.

Difference between expected and actual results : The analysis clearly highlights a significant discrepancy between the expected scientific aptitude set by NCERT (which emphasises scientific process skills , application, and higher-order thinking) and the actual learning outcomes of students reflected by NAS 2021. Students' performance, especially in the application and analysis of complex scientific concepts, is far below NCERT's targets. This gap highlights the need for an educational ecosystem that fosters deeper scientific understanding and critical thinking in students rather than mere memorisation of facts.

Research Findings:

This analysis brings forth several important findings regarding the development of scientific attitude in Indian school education, which explain the gap between NCERT objectives and NAS 2021 reports:

1. **NCERT's Strong Conceptual Framework:** NCERT's secondary level science learning outcomes provide a strong theoretical and conceptual foundation for scientific attitude (National Council of Educational Research and Training, 2021). These learning outcomes clearly emphasize scientific process skills such as

observation, hypothesis formulation, conducting experiments, analyzing data, and drawing logical conclusions. This indicates that the curriculum intends to develop deep scientific thinking and inquiry-based competence in students rather than mere factual knowledge.

2. **NAS results (deficits in higher-order thinking):** The NAS 2021 national and Rajasthan state reports indicate that Indian school students have significant weaknesses in higher-order thinking skills such as application, analysis and evaluation of scientific concepts (Ministry of Education, 2021). For example, the national average performance in Science in Class 10 is 295 mark, lower than the 319 marks of Class 8, and indicates that students struggle to understand and apply complex concepts. Rajasthan's performance is also in line with national trends , with the average score in Science in Class 10 being 294 marks (Ministry of Education, 2021). This result highlights a clear gap between the level of scientific aptitude envisaged by NCERT and the level actually being achieved by students.

3. **Unsatisfactory Performance in Implementation:** The NAS results clearly show that a significant implementation gap exists between NCERT objectives and classroom teaching-learning practices. If the learning outcomes promote scientific thinking, students' poor performance in higher-order thinking questions is an indication that teaching methods and assessment processes are failing to effectively achieve these objectives. Students still rely heavily on memorization-based learning, rather than being able to apply scientific concepts to real-life situations or critically analyse them.

4. **Contribution of Influencing Factors: Data presented in** the NAS reports also show that socio-economic factors, type of school (government vs. private) and geographical location (rural vs. urban) affect student performance. Students from urban and private schools performed better, suggesting disparities in availability of resources, teacher quality and learning environment. These disparities hinder the equitable development of scientific aptitude and further exacerbate existing gaps within the education system.

In short, while a theoretical base exists , the actual development of scientific attitude in Indian school education is far below expectations, and this is mainly due to the lack of development of higher-order thinking skills and unsatisfactory implementation of teaching-learning processes.

Conclusion:

This study concludes that while the Indian school education system has a well-defined and progressive curriculum framework (as reflected in NCERT's secondary level science learning outcomes) for developing scientific attitude , there is a clear and worrying lacuna in student learning outcomes as reflected by the reports of the National Achievement Survey (NAS) 2021. The NCERT learning outcomes clearly emphasise scientific process skills, critical thinking, observation, experimentation and problem-solving (National Council of Educational Research and Training, 2021), which are essential for a genuine scientific attitude.

However, the NAS 2021 national and Rajasthan state reports (Ministry of Education, 2021) confirm that students are struggling to develop these higher order thinking skills. Students' performance in science, particularly in application, analysis and evaluation of concepts, is significantly weaker than in recall of knowledge. The national average performance (295 marks) and Rajasthan's average performance (294 marks) in science in Class 10 are lower than Class 8 performance, indicating a decline in students' ability to understand and apply complex scientific concepts. This discrepancy highlights a critical implementation gap within the education system, where desired learning outcomes are not being achieved at the expected levels.

This gap is mainly due to factors such as the continuation of traditional teaching methods, lack of adequate professional development and training for teachers, an assessment system that promotes rote learning and a lack of adequate laboratory facilities and resources in schools especially in rural areas. As a result of these challenges, students fail to apply scientific principles to real-life situations or develop the ability to think scientifically, Additionally, socio-economic factors and type of school also contribute to inequalities in student learning outcomes hindering the equitable development of scientific attitudes.

In summary, to make Indian school education relevant to the needs of the 21st century it is

necessary to focus on developing true scientific aptitude in students rather than merely accumulating scientific knowledge. This goes beyond mere policy intentions and demands fundamental shifts in teaching practices, teacher capacity building and adopting a holistic assessment system that promotes scientific process skills and critical thinking. This is a crucial step towards creating an educational ecosystem that values curiosity, inquiry and evidence-based reasoning enabling India's youth to become more informed and innovative citizens of the future.

For effective development of scientific attitude in Indian school education a multi-dimensional approach is needed to address the current challenges and align the goals of NCERT with the outcomes of NAS.

- **Improvement in teaching-methodology:** Teachers should be encouraged to adopt inquiry-based learning, experiential learning and problem-solving approaches. Students should be provided with opportunities to apply scientific concepts in hands-on experiments and real-life situations. The NCERT learning outcomes themselves suggest "linking projects and experiments to real-life experiences" and "encouraging group work and peer support" (National Council of Educational Research and Training, 2021, p. 1).

- **Teacher Capacity Building:** Teachers should be provided with continuous professional development and training in innovative teaching methods, critical thinking and assessment techniques that promote scientific attitude. They should be equipped with the necessary skills to develop scientific curiosity and logical reasoning in students.

- **Enhancement of Curriculum and Textbooks:** Textbooks should include more real-life examples, case studies and experimental activities that motivate students to understand and apply scientific principles. Learning should be made more relevant and engaging.

- **Changes in the Evaluation System:** Assessment should focus on assessing students' conceptual understanding, application skills, and higher-order thinking rather than mere memorization of facts . This should include practical work , project-based assessments, and critical analysis.

- **Strengthening of Laboratory Facilities:** All schools especially in rural areas should be provided with adequate and well-equipped science laboratory facilities. Students should get regular opportunities to perform experiments and participate in scientific processes.
- **Parent and Community Involvement:** Raising awareness among parents and the community about the importance of scientific temper. Creating a supportive environment to foster scientific curiosity at home and in the community.

Future Scope:

This study focused on the analysis of primary documents. Future research could include qualitative studies of direct classroom practices, teacher-student interactions and the impact of specific teaching interventions on scientific attitude development. A more in-depth analysis of district-level data from NAS 2021 across different states could also provide more nuanced insights into regional disparities in scientific attitude development and their underlying causes.

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