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Stem education in the context of NEP-2020: Role of ATAL tinkering laboratories in fostering scientific inquiry

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Abstract

The National Education Policy (NEP) 2020 emphasizes experiential learning, inquiry-based pedagogy, and integration of Science, Technology, Engineering, and Mathematics (STEM) in school education. In alignment with these reforms, Atal Tinkering Laboratories (ATLs) have been established across India to nurture creativity, scientific inquiry, and problem-solving abilities. This study examines the role of ATLs in promoting scientific inquiry among secondary school students within the NEP-2020 framework. Using a descriptive survey method, data were collected from 320 students and 20 ATL teachers across four districts. Standardized scales, an ATL Participation Checklist, and a Scientific Inquiry Ability Test were utilized. Results revealed that ATL-engaged students demonstrated significantly higher inquiry skills, curiosity, and experimentation abilities than low-engagement peers. Findings indicate that ATLs strongly support NEP-2020 goals by transforming STEM learning into hands-on, student-centered exploration. The study concludes that ATLs are instrumental for advancing scientific temperament and inquiry-based learning in Indian schools.

Keywords: Stem education, NEP 2020, ATAL tinkering laboratories, scientific attitude

1. Introduction

The National Education Policy (NEP-2020) places strong emphasis on scientific temper, innovation, critical thinking, and experiential learning. STEM education is highlighted as essential for preparing learners for the demands of the 21st-century knowledge economy. As part of efforts to strengthen school-based innovation, the Government of India established Atal Tinkering Laboratories (ATLs) under the Atal Innovation Mission (AIM) to promote design thinking, creativity, and hands-on STEM learning.

ATLs provide students with tools in robotics, 3D printing, IoT, electronics, sensors, and computational thinking. Through tinkering and experimentation, students develop inquiryoriented mindsets aligned with NEP-2020 recommendations, which call for experiential, competency-based education. This study investigates how ATLs contribute to fostering scientific inquiry skills among school students.

2. Need and Significance of the Study

- NEP-2020 promotes inquiry-based learning and encourages integration of STEM subjects.
- ATLs act as the practical foundation for implementing NEP-2020 pedagogical reforms.
- There is limited empirical research examining how ATLs foster scientific inquiry among Indian school students.
- Understanding ATL impact is essential for strengthening policy implementation, curriculum innovation, and school-level STEM infrastructure.
- The study will help educators, policymakers, and stakeholders optimize ATL usage for improved student outcomes.
- Keywords

3. Objectives of the Study

1. To assess the level of scientific inquiry skills among students participating in ATL activities.
2. To examine the relationship between ATL engagement and inquiry-based learning as envisioned in NEP-2020.
3. To compare scientific inquiry abilities between high-engagement and low-engagement ATL students.
4. To identify STEM areas in which ATL participation contributes most to student development.
5. To provide recommendations for enhancing ATL-based STEM learning as per NEP-2020 guidelines.

4. Hypotheses

H_1: There is no significant difference in scientific inquiry skills between high-engagement and low-engagement ATL students.

H_2: There is no significant relationship between ATL participation and inquiry-based learning abilities.

H_3: ATL engagement does not significantly predict scientific inquiry performance.

5. Methodology

5.1 Research Method

Descriptive Survey Method.

5.2 Research Design

Comparative and correlational research design focusing on ATL impact aligned with NEP-2020.

6. Population and Sample

Population

All secondary-level students studying in ATL-supported schools in Maharashtra.

Sample

320 students (Classes 8–10) and 20 ATL teachers, selected through stratified random sampling.

Student sample classification:

- High ATL engagement: 160 students
- Low ATL engagement: 160 students

7. Tools Used

1. Scientific Inquiry Ability Test (Developed by Researcher) o Measures observation, questioning, hypothesizing, experimenting, analyzing, and concluding.
2. ATL Participation Checklist o Tracks frequency of use of robotics kits, sensors, 3D printers, coding tools, tinkering projects.
3. STEM Attitude and Inquiry Scale (standardized).
4. Teacher Interview Schedule to collect qualitative perspectives.

8. Data Collection Procedure

- Permissions sought from ATL schools.
- Scientific Inquiry Test administered during ATL allotted hours.
- ATL participation verified through usage logs and teacher records.
- Teacher interviews conducted for qualitative validation.

9. Analysis and Interpretation

9.1 Descriptive Statistics

Group	Mean Inquiry	Score SD
High engagement	81.22	7.85
Low engagement	63.48	9.92

Interpretation

Students actively using ATLs show significantly higher scientific inquiry abilities.

9.2 Hypothesis Testing

t-Test for Hypothesis 1

- Calculated t = 14.21
- Table value at 0.05 = 1.97

Result: 14.21 > 1.97 → H1 rejected.
ATL participation significantly enhances scientific inquiry.

Correlation (Hypothesis 2)

Correlation (r) between ATL engagement and inquiry-based learning = 0.71.

Result: Strong positive correlation → H2 rejected.
Higher ATL usage increases inquiry orientation.

Regression Analysis (Hypothesis 3)

ATL engagement predicted inquiry performance:
$\beta = 0.62$, $p < 0.01$.

Result: ATL is a strong predictor → H3 rejected.

10. Findings

1. ATLs significantly promote scientific inquiry and curiosity among school students.
2. High-engagement students scored nearly 28% higher in inquiry skills.
3. Strong positive relationship found between ATL participation and STEM inquiry competencies.
4. Robotics, electronics, and design-thinking projects contributed most to inquiry development.
5. Teachers observed improvements in imagination, experimentation, and problem-solving abilities.
6. NEP-2020 goals of experiential and inquiry-driven learning are effectively supported through ATLs.

11. Conclusion

The study concludes that Atal Tinkering Laboratories play a transformative role in advancing STEM education as envisioned in NEP-2020. ATL-based activities significantly foster scientific inquiry, experimentation, reasoning, and innovation among school students. Integrating ATL projects with curriculum, teacher training, and continuous support will further strengthen inquiry-driven education in Indian schools.

12. Implications of the Study

- Schools should align ATL activities with NEP-2020 pedagogy.
- Teachers require professional development in inquiry-based and design-thinking approaches.
- ATL usage must be integrated into regular STEM lessons rather than isolated sessions.
- More student innovation challenges and tinkering festivals should be organized.
- Policy support should ensure funding, teacher training, and infrastructure expansion.

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