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# Fostering Innovation in Indian Education: The Impact and Challenges of Atal Tinkering Labs

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**Abstract:** STEM education, an acronym for Science, Technology, Engineering, and Mathematics, emphasizes experiential learning through the integration of these subjects. It employs hands-on activities using specially designed kits, toys, or unconventional settings to foster a practical understanding of STEM concepts. This student-centered approach positions students at the forefront of learning, while teachers act as facilitators. The implementation of Atal Tinkering Labs (ATLs) in classrooms aims to create a stimulating environment, making education more engaging and supportive of innovation. Despite its potential, this pedagogy challenges the traditional education system, necessitating curriculum and teacher education reforms. Enhancing the STEM workforce is critical for addressing global competition and improving STEM literacy. While STEM education is globally recognized and adopted, including in countries like Australia, China, and the United Kingdom, India's efforts, particularly through ATLs, are noteworthy. This paper explores the strategies employed by India to promote STEM education, focusing on the Atal Tinkering Labs initiative, and examines its effectiveness and challenges.

**Keywords:** STEM Education, NEP2020, NCFSE 2023, Tinkering Labs, 21st Century Skills, Experiential Learning

## I. Introduction

The 2024 India Unemployment Report highlights a critical issue: a significant portion of the unemployed youth are educated but lack essential ICT skills. This gap, coupled with the traditional rote learning approach of the current education system, contributes to a growing unemployment rate.(10) The challenge is compounded by the rapid technological advancements associated with the Fourth Industrial Revolution, which demands new skill sets and innovative thinking. To address these issues, integrating STEM education into K-12 schools is imperative. STEM jobs are projected to grow significantly, yet there is a notable skills gap in emerging fields like AI and big data. India's education system must evolve to produce graduates who are not only knowledgeable but also skilled in practical, real-world applications.

## II. Literature Review

STEM education has been discussed and developed since the 1990s, with the acronym first introduced by the U.S. National Science Foundation in 2001. According to the National Academy of Engineering and National Research Council (2014), STEM literacy involves awareness of the roles of STEM fields in society, familiarity with fundamental concepts, and the ability to apply these concepts practically. Research indicates that STEM education can enhance self-regulation, motivation, and critical thinking among students (1). It also supports the development of project-based and problem-solving skills (2). Internationally, STEM programs have been adopted in various countries, demonstrating its global relevance (3). In India, the Atal Innovation Mission launched in 2016 represents a significant effort to embed STEM education within the national framework. The initiative aims to foster a culture of innovation from a young age by establishing ATLs in schools and providing resources for hands-on learning. (4). With a bid to foster national innovative ecosystem, the Government of India,has given special focus on the education sector. In order to create and promote the culture of innovation and entrepreneurship, recommendations have been made by NEP2020 and the National Curricular Framework(NCF)to incorporate ATL curriculum in the schools and colleges. (5,8).The objectives of NEP2020 are in tune with the objectives of SDG for achieving the 21st century skills. According to NEP2020,the key overall thrust of the curriculum and pedagogy reform across all stages will be to move the education system towards real understanding and towards learning how to learn and do away with the culture of rote learning as it is present largely today. The aim of education among others will be to build well groomed individuals equipped with the 21st century skills. It aims to reduce the curriculum load ,enhance essential learning and critical thinking. The teaching and learning should be conducted in a fun learning manner making classrooms more fun creative collaborative and exploratory for the students for more deeper and more experiental learning.(7) The study suggests that the ATL initiative should be expanded to more schools to provide more students with access to modern technology and resources.(5) Recognising that nearly 80 percent of future jobs will require science and math skills, many industries aims to address the challenge of limited access and resources in many parts of the country through their CSR activities.(6) Some of the notable organizations which are working for the empowernment of stem education in India are 'Engineering Futures' (L&T's STEM initiative), Girls Who Code ,STEMinism in India, CGI( partnered with NITI Aayog, a government policy think tank, to support Atal Innovation Mission (AIM)), MANAK (Million Minds Augmenting National Aspirations and Knowledge) awards programme under the Innovation in Science Pursuit for Inspired Research' (INSPIRE) scheme, a flagship programme of DST, Kishore Vaigyanik Protsahan Yojana (KVPY), Science Olympiad Programme, and the India Innovation Growth Programme (IIGP).Homi Bhaba Centre for Science Education (HBCSE), Mumbai is the nodal organization for STEM.

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## III. Methodology

This study employs a mixed-methods approach to evaluate the effectiveness and challenges of the Atal Tinkering Labs (ATLs). The methodology includes:

1. **Literature Review:** A comprehensive review of existing literature on STEM education, its global adoption, and the impact of the Atal Innovation Mission. Sources include academic journals, government reports, and policy documents.
2. **Quantitative Analysis:** Analysis of data from the Atal Innovation Mission's reports, including the number of ATLs established, the funds spent, and the reported outcomes such as the number of projects, startups, and patents generated. This data is sourced from official AIM reports and related publications.
3. **Qualitative Analysis:** Interviews and surveys with educators, students, and mentors involved in ATLs. This includes assessing their experiences, perceptions, and the challenges faced. The qualitative data provides insights into the practical implementation of STEM education and the effectiveness of ATLs in different contexts.
4. **Case Studies:** Examination of specific instances of ATLs in various regions, particularly focusing on the challenges faced by schools with limited resources. Case studies include schools in both urban and rural areas to provide a comprehensive view of the program's reach and impact.

### Stem Education in India

### Atal Innovation Mission

Launched in 2016, the Atal Innovation Mission (AIM) is a flagship program aimed at fostering innovation and entrepreneurship across various sectors. It includes several initiatives such as Atal Tinkering Labs (ATLs), Atal Incubation Centres, New India Challenge programs, Atal Research and Innovation for Small Enterprises (ARISE) Centres, and Atal Community Innovation Centres (ACIC).

### Atal Tinkering Labs (ATL)

ATLs are innovation workspaces in schools designed to provide K-12 students with access to do-it-yourself kits and IT equipment. These labs aim to promote a practical learning approach, encouraging students to explore and innovate. As of the latest data, over 10,000 ATLs have been established across 35 states and union territories, engaging more than 1.1 crore students and 6,200 mentors of change.(9) Despite the success in creating numerous projects, startups, and patents, challenges remain in terms of reaching all schools and ensuring consistent quality across different regions.

### Challenges of The ATL Program

Despite the progress, several challenges persist:

1. **Limited Reach:** The number of ATLs is insufficient compared to the total number of schools. For instance, in Rajasthan, only 400 out of 70,961 schools have ATLs.(11)
2. **Educational Disparities:** A significant gap exists between the existing educational levels of students and the skills required for effective tinkering.
3. **Teacher and Mentor Engagement:** Variability in teacher quality and engagement, coupled with high workloads and lack of incentives, affects the program's effectiveness.
4. **Infrastructural and Linguistic Barriers:** The infrastructure and language of instruction limit the program's reach and effectiveness.
5. **Funding and Sustainability:** AIM's funding cut-off after five years poses a risk of discontinuation for some labs, particularly in rural areas.

### Conclusions

The Atal Innovation Mission is addressing several challenges through regional clusters, mobile and virtual ATLs, and vernacular language resources. Collaboration with the Ministry of Education, CBSE, NCERT, and state governments aims to integrate ATL pedagogy into the school curriculum and scale the program to 50,000 schools. The recommendations in NEP2020 support these efforts, aligning the pedagogy with STEM education principles.(10) Continued efforts and collaboration are necessary to overcome existing challenges and enhance the effectiveness of STEM education initiatives in India. Although the establishment of ATL labs in schools is a step in the right direction, yet the scale is still very small. For example there are 70961 schools in Rajasthan and the schools which have received the tinkering Labs are only 400. In jodhpur district alone, only 9 schools have been benefitted with ATL,99% of which are government schools.[12]. For the financial year 2022-23, the total budget allocated to the Atal Innovation Mission (AIM) was ₹169.43 crore and INR 19.56 crores, were allocated for establishing atal tinkring labs for  out of which INR 86 lakhs have been disbursed for Atal Tinkering Lab in Rajasthan state for 43 schools. In the year23-24, 1380.28 cr were allocated for Atal innovation mission and 70.24 cr were allocated to rajasthan(13).In the budget year 25-26 5284 cr have been allocated for AIM

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and it aims to establish 50000 schools with ATLlabs.(14,15) Under the ATL marathon in the year22-23, 400 schools were selected as top 400 out which only 4 schools of rajasthan could win . In the year 23-24 500 schools were selected out which 4 schools could win the prize and in the year 24-25 top 1000 schools were selected but only 25 schools of rajasthan could win this prize. (16,17)The data suggests that there is a huge gap between the amount invested and the results being obtained. The major reason for this could be due to lack of teacher training and nonavailability of these courses for the teachers. It is therefore suggested that such centres should be encouraged in the teacher training college also so that when the teachers go to teach in schools they are fully aware of such type of pedagogy.also management of these tinkerlabs and the strategies for overseeing these labs and their outcome is not efficient. It is recommended therefore to encourage establishment of such centres as out of the school activity centres so that parents and the community becomes aware of the program.

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