Atal Tinkering Labs Expansion in Government Schools

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Executive Summary

A. Atal Tinkering Labs (ATLs) are set up in 10,000 schools across 35 states and 722 districts, providing students with hands-on learning opportunities. They bridge the gap between theoretical knowledge and real-world application.
B. Over 60% of ATLs are in government schools, with 96% in girls' or co-ed institutions, ensuring STEM education is accessible to all. This inclusivity allows students from diverse backgrounds to participate in innovation.
C. ATLs engage 1.1 crore students, offering tools like 3D printers, robotics kits, and IoT devices for hands-on learning. This exposure helps students develop practical skills for future careers.
D. More than 6,200 "Mentors of Change" guide students, providing technical expertise and fostering collaboration. Their mentorship builds confidence and encourages problem-solving.
E. Students have developed 1.6 lakh projects addressing real-world challenges, from smart farming to healthcare innovations. These projects equip students with skills while contributing to society.
F. ATLs enhance critical thinking by encouraging students to analyze problems and experiment with solutions. This approach promotes independent thinking and creativity.
G. ATLs nurture an entrepreneurial mindset, helping students take risks and turn ideas into market-ready solutions. This fosters innovation and leadership from an early age.

I. Introduction

A. In recent years, the integration of technology into education has become imperative to address the global shortage of engineers, scientists, and IT professionals. Emphasising STEM (Science, Technology, Engineering, and Mathematics) education equips students with essential 21st-century skills, bridging the gap in skilled human resources. A pivotal aspect of this educational evolution is the concept of "tinkering," which involves hands-on learning, experimentation, and problem-solving through practical experiences. Globally and within India, tinkering has gained prominence as a means to foster innovation and skill development among students.

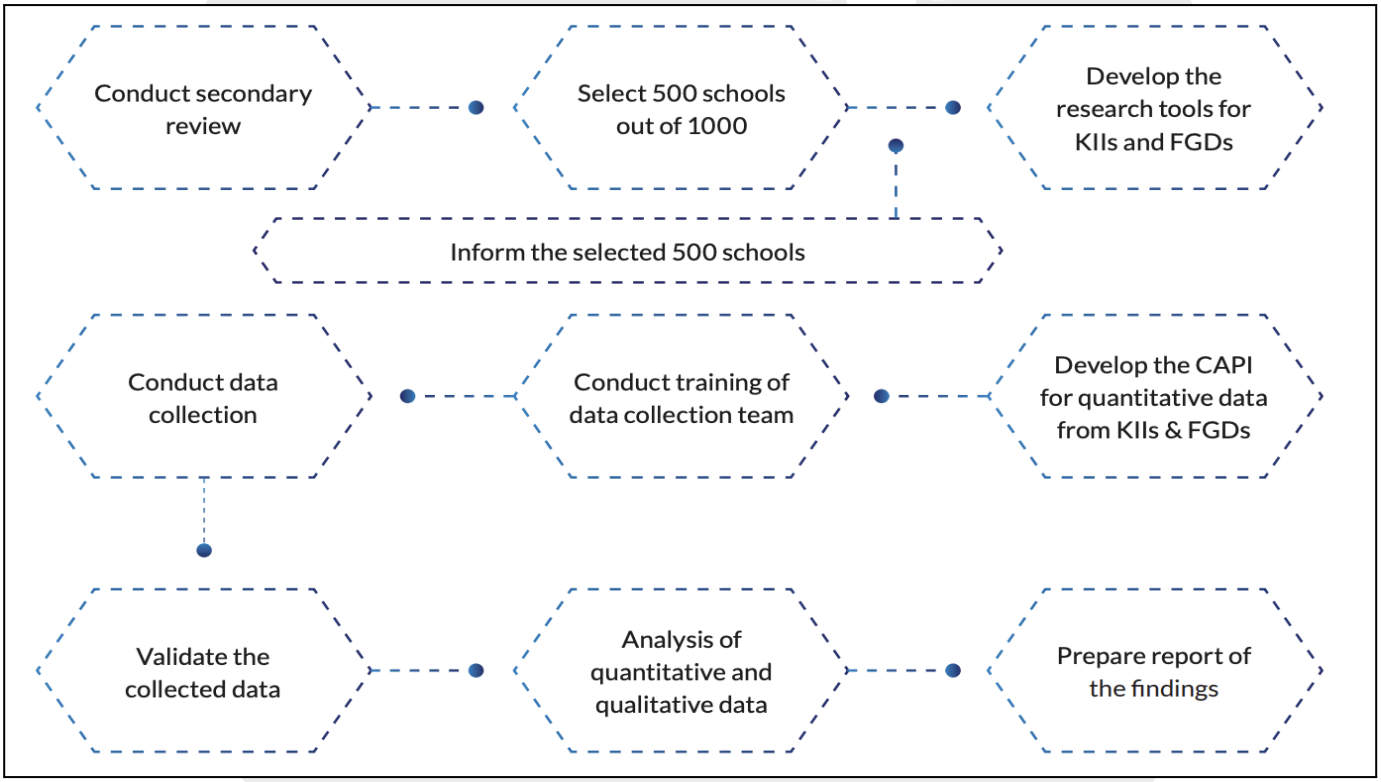
B. In alignment with this approach, **the Atal Innovation Mission (AIM) was launched by the Indian government in 2016** to cultivate a culture of entrepreneurship and innovation. Housed within the NITI Aayog, AIM serves as an umbrella organisation, harmonising innovation policies across central, state, and sectoral ministries. **Its initiatives span various levels, from higher secondary schools to research institutions and the MSME industry, promoting a robust ecosystem of innovation through public-private partnerships.**

C. The Atal Tinkering Labs focus on nurturing creativity and scientific temperament at the school level. These labs provide students with the opportunity to engage in ideation, design thinking, and rapid prototyping, thereby enhancing their problem-solving skills and broadening their intellectual horizons. **As of February 2025, approximately 10,000 ATLs have been established across India**, offering students a platform to develop solutions for real-world challenges and showcase their innovations on national and global stages.

D. In the Union Budget 2025-26, the government has unveiled a comprehensive plan to enhance innovation and scientific curiosity among students by **establishing 50,000 more Atal Tinkering Labs (ATLs) in government schools over the next five years**. This initiative aims to cultivate a spirit of curiosity and innovation, fostering a scientific temper among young mind and seeks to bridge the gap between theoretical knowledge and practical application, preparing students for future challenges in science and technology

II. Analysis

In a recent study conducted under the Atal Innovation Mission[1], **it collected secondary data from 1,000 schools across various regions and further evaluated 500 schools out of those 1,000 as primary data** to perform a gap analysis on the data, conduct an online survey, and analyse the findings from both the survey and secondary data. The survey provided a comprehensive understanding of the program's impact and effectiveness and also served as a valuable resource for further refining the ATL program and amplifying its positive influence on students' holistic development.

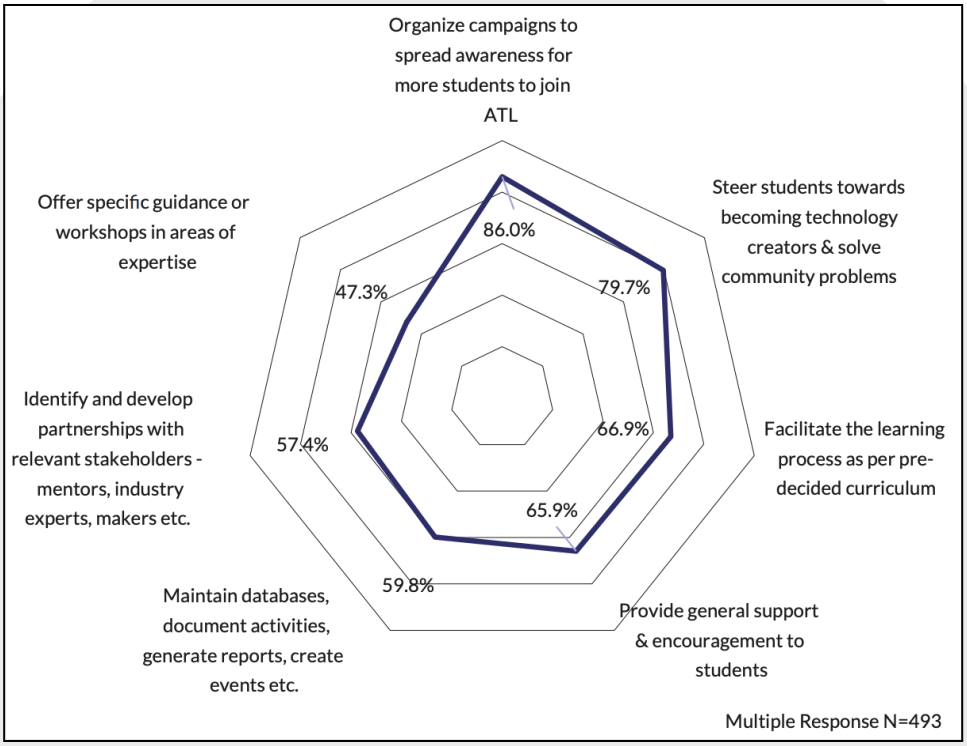


At the time of assessment of primary data collection for ATLs, it faced challenges such as incorrect or missing contact numbers, leading to unscheduled visits and refusals. Some schools denied entry despite prior communication, while the absence of key stakeholders required multiple visits. Extreme weather and floods disrupted the process, and newly appointed officials lacked awareness of ATL operations, prolonging interactions.

1. **The survey revealed that most ATLs (74%) were built within six months without delays**, and each lab was provided with adequate space and basic facilities.

[1] ATL Survey

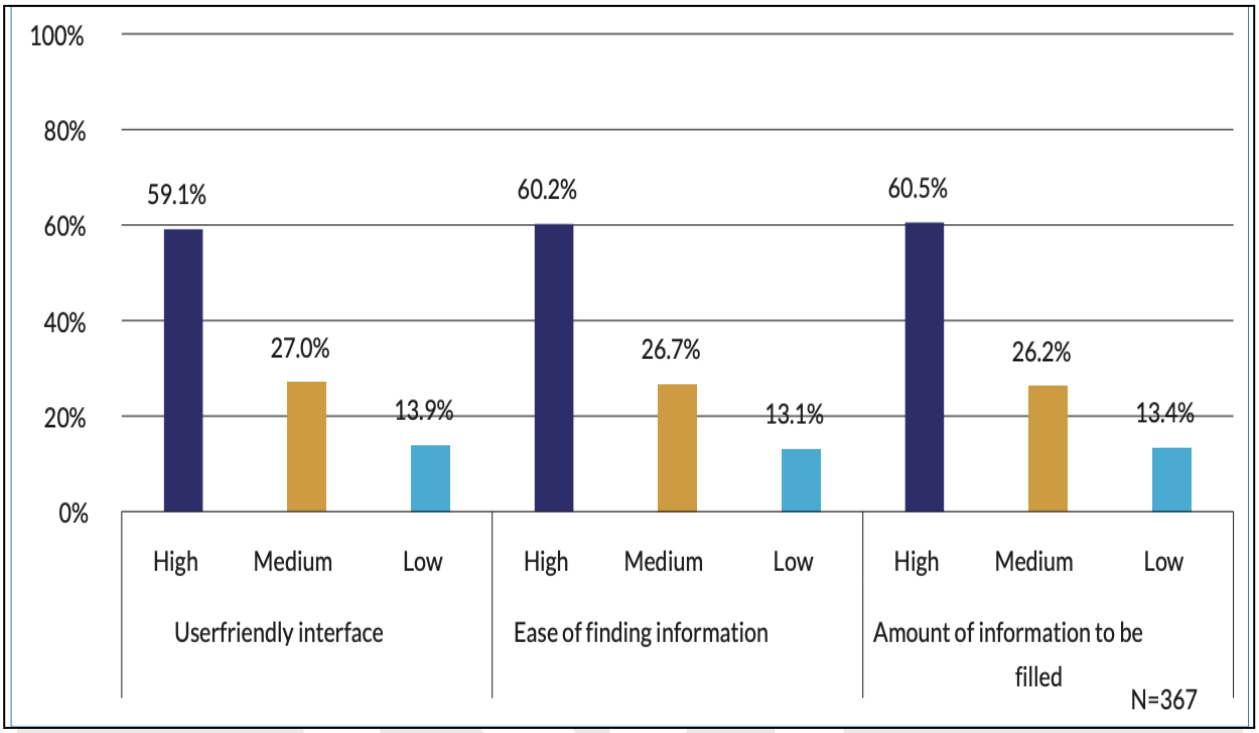
2. 21.3% of ATLs had exclusive ATL incubation centres, who spent 92% of their time on ATL work, with assistants in 57% of cases. Meanwhile, 77% of ATL centres also handled teaching, dedicating only 28% of their school time to ATL work, with assistants in 54% of such ATLs.
3. Within labs, only a small proportion (19%) of schools reported having dedicated Artificial Intelligence labs.
4. **A major challenge identified was the shortage of teachers, with 58.2% not having a STEM background, impacting their ability to guide students effectively.**
5. Out of the 70% of the schools that reported their teachers having attended the training, many also highlighted numerous challenges faced while attending the training.



6. Even when teachers were available, the absence of a structured curriculum hindered effective learning. Additionally, teachers lacked regular workshops to stay updated on the latest technological advancements, further affecting the quality of instruction.
7. 34% of schools lacked knowledge and training on the ATL dashboard, while 28% faced time constraints. Additionally, 26% struggled with navigation, 24% cited limited support, and 18% had difficulty managing data.
8. **Student participation and engagement in ATL events engagement had been low as only 10% of the ATLs reported participation.**

9. The majority of the ATL incubation centres (67%) taught science, followed by mathematics (21%) and computer science (16%). Less than 10% of the ATL centres taught electronics, and less than 5% centres taught English, arts/social science, regional language, and commerce.

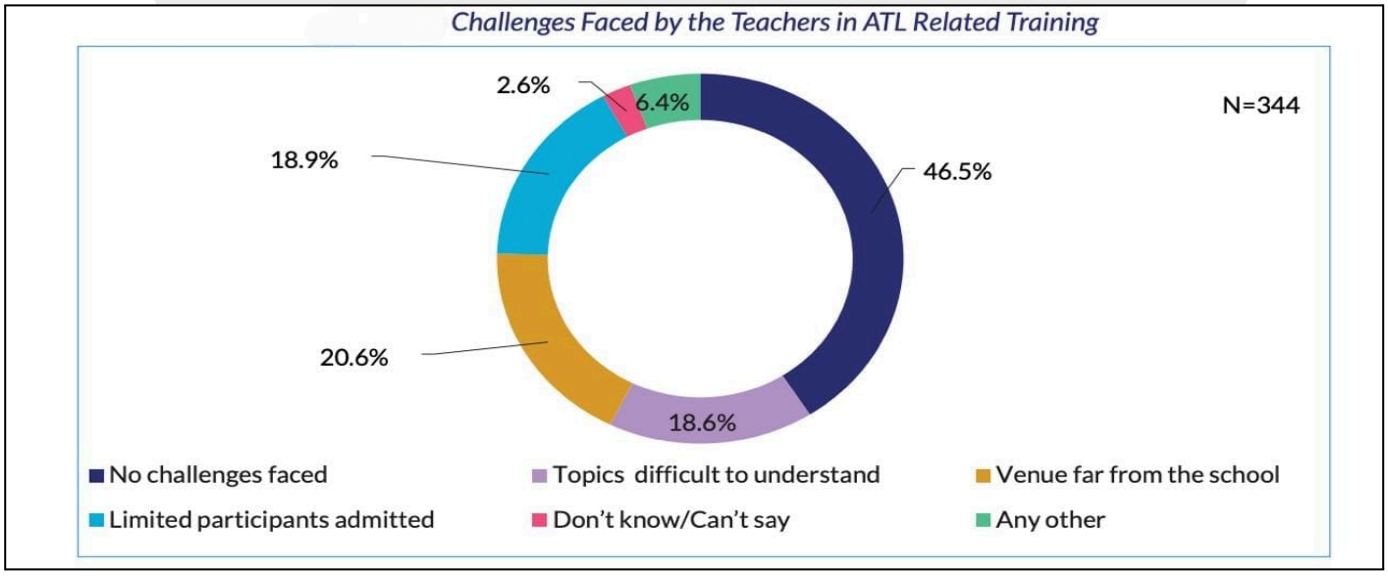
10. More than 50% of the schools reported a high level of satisfaction with its user-friendly interface, ease of finding information, and amount of information needed to be filled out on the dashboard. However, there is room for enhancing the overall user experience.



The analysis reveals several critical challenges that hinder the effective implementation and impact of ATLs, including:

1. A significant challenge for ATL centres is the shortage of qualified STEM teachers, with 58.2% lacking a STEM background. This limits their ability to guide students in using advanced lab equipment, leading to underutilization of resources. Without proper mentoring, students struggle to fully engage in hands-on learning and innovative projects, diminishing the impact of ATLs.
2. While ATLs provide modern hardware, the absence of a structured curriculum remains a key barrier to effective learning. Many schools report that, despite teacher availability, the lack of a standardised framework hinders project-based learning. This gap prevents students from gaining a deeper understanding of concepts and reduces the effectiveness of ATL initiatives in fostering innovation.
3. Maintaining and updating ATL equipment poses a major challenge, particularly in rural schools. The absence of trained personnel results in prolonged downtime, affecting the lab's functionality. With no dedicated technical support, schools struggle to address malfunctions, making it difficult to ensure that students have continuous access to working tools and technology.

4. **Many ATL staff members lack the necessary training to efficiently manage the dashboard and lab activities**, with 34% of schools reporting insufficient training. Additionally, 26% find the dashboard interface difficult to navigate, and 24% feel there is limited support available. These challenges make it harder for schools to effectively document, track, and optimise their ATL operations.
5. The effectiveness of ATLs is further hindered by the workload of ATL In-Charges. Only 21.3% of ATLs have exclusive in-charges dedicating 92% of their time to ATL work, while 77% manage both ATL responsibilities and teaching. As a result, ATL-related work is reduced to just 28% of their total school time. This divided attention limits their ability to provide proper guidance and mentorship to students.
6. Despite ATLs being designed to foster innovation, student participation remains low, with only 10% of ATLs reporting active involvement in events and projects. Without strong student engagement, the impact of these labs is significantly reduced. This lack of participation may stem from insufficient mentoring, unclear learning pathways, or a lack of structured activities that encourage hands-on experimentation.
7. T**he distribution of subjects taught in ATLs is imbalanced**, with 67% of centres primarily focusing on science, 21% on mathematics, and 16% on computer science. Less than 10% of centres incorporate electronics, while under 5% include subjects like English, arts, social sciences, regional languages, or commerce. This narrow focus limits interdisciplinary learning and prevents students from exploring a diverse range of skills.
8. While ATLs receive initial funding for setup, **many schools struggle with sustaining financial support for maintenance and upgrades.** Without a consistent budget, equipment becomes outdated, and necessary resources become scarce. This financial uncertainty hampers the long-term success of ATLs and restricts their ability to provide high-quality learning experiences.
9. While over 50% of schools find the ATL dashboard user-friendly, there is still room for improvement. Schools face challenges such as time constraints (28%), difficulty in navigating the interface (26%), and problems with tracking and managing data (18%). These issues create administrative burdens for teachers and reduce the efficiency of ATL operations, making it harder to document progress and measure impact.



ATLs are expected to engage the community by extending their benefits to students beyond the host school, with schools maintaining records of external participation. However, only 40% of ATLs currently allow access to other schools. Given that brand value is a key motivator for ATL applications, AIM should guide schools on broader inclusion and consider setting engagement targets, including formal collaboration agreements, to ensure wider accessibility and impact.

This nuanced analysis of ATL ICs' responses facilitating the impact of the ATLs on the school and its ecosystem shows that 69% of the schools reported improved academic performance after the establishment of the ATL, followed by 63% reporting an increase in demand for admission. 60% of the schools also reported that after the establishment of the ATL, there has been an enhancement in the scientific temper of the students. Furthermore, more than 50% of the schools reported increased engagement with the schools and the community.

ATLs in schools have also promoted increased teacher-student engagement, creating opportunities to integrate practical aspects with theoretical teachings. This engagement not only enhances the quality of education but also fosters innovation skills among both students and teachers.

III. Recommendations

A. To enhance the effectiveness of ATLs, **it is essential to strengthen teacher training in STEM education through government initiatives, research organisations, and industry collaborations under the Atal Innovation Mission**. Many educators lack the necessary expertise to guide students in using lab equipment effectively, leading to underutilisation of resources. Regular workshops, certification programs, and hands-on training sessions can equip teachers with the skills needed to mentor students and foster innovation.

B. **A structured curriculum should be developed to provide clear guidance on utilising ATL resources effectively.** Without a well-defined framework, students may struggle to engage in meaningful hands-on learning. The Atal Innovation Mission, in collaboration with educational boards, universities, and STEM organisations, should create standardised modules covering design thinking, problem-solving, and project-based learning to ensure ATL activities align with educational objectives.

C. Maintaining and upgrading equipment remains a challenge, especially in schools that lack technical support. The government should establish a centralised system for troubleshooting, with public-private partnerships facilitating equipment maintenance. Regular servicing should be supported by technology firms, while training on equipment handling can be provided by research institutions and technical universities. Additionally, online resources such as video tutorials and virtual troubleshooting support can help schools address minor technical issues independently.

D. ATL in-charges often juggle multiple responsibilities, making it difficult to dedicate sufficient time to lab-related activities. Schools should consider appointing dedicated facilitators, with financial and operational support from the Atal Innovation Mission and state education departments. Collaborations with corporate CSR initiatives and ed-tech organizations can also help recruit part-time mentors and technical assistants to ensure smooth ATL operations.

E. Student participation in ATL activities needs to be encouraged through structured programs, competitions, and mentorship initiatives. The Atal Innovation Mission, in partnership with private organizations, innovation hubs, and universities, should introduce national-level challenges and hackathons to boost student engagement. Schools should also work with NGOs and local innovation communities to set up peer mentorship programs, where experienced students guide newcomers in project-based learning.

F. **The subject focus within ATLs should be broadened to promote interdisciplinary learning.** While science and technology are primary areas, integrating entrepreneurship, arts, and social science-based problem-solving will create a more holistic learning experience. This expansion should be led by education boards and innovation councils in collaboration with think tanks and multidisciplinary research institutes to ensure diverse learning opportunities.

G. Continuous financial and infrastructure support is crucial for ATLs to maintain their effectiveness. While initial funding helps set up labs, additional resources are needed for regular upgrades, equipment maintenance, and expanding accessibility. The government should introduce grants and subsidies for underprivileged schools, while corporate sponsorships and CSR initiatives from technology firms can provide additional funding. Schools can also explore partnerships with NGOs and crowdfunding platforms to secure continuous financial support.

H. **The ATL dashboard plays a key role in tracking lab activities and student progress, but usability challenges need to be addressed. Improving the interface, simplifying navigation, and offering more training opportunities for teachers and administrators should be managed by the Atal Innovation Mission in collaboration with software development firms and ed-tech companies.** Schools should also receive technical assistance from government digital education initiatives to ensure smooth integration of the dashboard into daily operations.

I. Collaboration between schools and external organisations can significantly enhance the impact of ATLs. Universities, research institutions, and industry leaders should work together with the Atal Innovation Mission to provide mentorship, internships, and real-world project exposure. Expanding initiatives like the Mentor of Change program can ensure that each ATL has access to experienced professionals who guide students in refining their ideas and projects.

J. ATLs should also extend their impact beyond individual schools by collaborating with neighbouring institutions. Education departments and district-level innovation councils should establish shared resource centres where students from multiple schools can access ATL facilities. Initiatives like ATL Sarthi, which promote inter-school collaboration, should be strengthened with support from local governing bodies and non-profit educational organisations.

K. **Implementing real-time monitoring systems will help ensure continuous improvement in ATL operations.** The Atal Innovation Mission, in partnership with data analytics firms and government education agencies, should develop tracking tools to measure student participation, project outcomes, and resource utilization. Schools should be given access to these tools through centralized digital platforms, enabling data-driven decision-making and efficient resource allocation.

Other nations also have innovation labs like MIT's Fab Labs and Finland's Experimentation Labs, which focus on hands-on learning and problem-solving. MIT's Fab Labs are small-scale workshops equipped with advanced fabrication tools, allowing users to design and create locally with technologies like 3D printing and CNC machining. Finland's Experimentation Labs, part of its National STEM Strategy, empower teachers and school leaders to develop creative solutions to local challenges through collaborative learning. These labs provide structured environments that foster innovation, skills development, and real-world applications in education.

To enhance the effectiveness of India's Atal Tinkering Labs (ATLs), adopting strategies from MIT's Fab Labs and Finland's Experimentation Labs can be beneficial. For instance, MIT's Fab Labs have systematised support programs like the Fab Academy, offering advanced digital fabrication instruction through a hands-on curriculum. Similarly, Finland's Experimentation Labs engage teachers and administrators in co-creating solutions to local challenges, fostering a culture of shared learning and innovation. Implementing continuous training programs for educators, akin to Finland's approach, can keep them abreast of the latest technological advancements and teaching methodologies. Developing a structured curriculum, as seen in MIT's Fab Academy, can provide clear guidance for effective learning within ATLs. Establishing robust monitoring systems, such as real-time dashboards, can facilitate data-driven improvements and track the labs' performance efficiently. By integrating these strategies, ATLs can enhance their impact, nurturing a generation of innovators equipped to address real-world challenges.

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