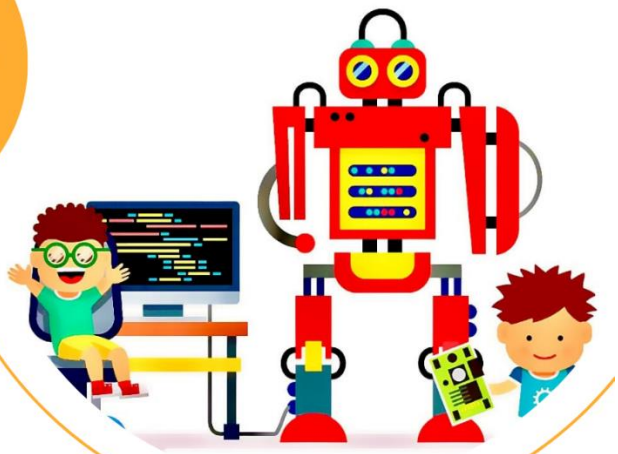
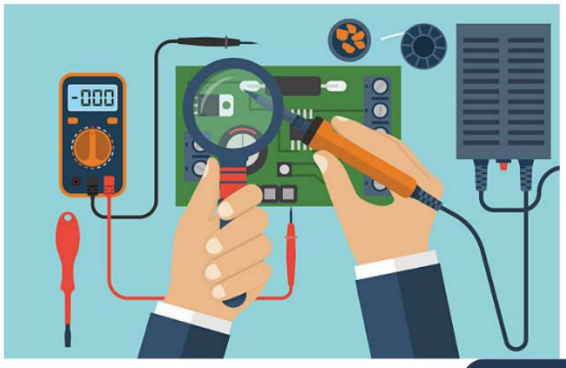
2024-25

Effectiveness of Atal Tinkering Lab on Learning Outcomes and in Promoting 21st Century Skills for Secondary School Students of Western Region

PAC 23.08





REGIONAL INSTITUTE OF EDUCATION, NCERT, SHYAMLA HILLS, BHOPAL, (M.P.)

Effectiveness of Atal Tinkering Lab on Learning Outcomes and in Promoting 21st Century Skills for Secondary School Students of Western Region

RESEARCH REPORT

PAC 23.08

Principal Investigator

Dr. Shivalika Sarkar

DEPARTMENT OF EDUCATION IN SCIENCE AND MATHEMATICS

REGIONAL INSTITUTE OF EDUCATION, BHOPAL

(National Council of Educational Research and Training)

REGIONAL INSTITUTE OF EDUCATION

Shyamla Hills, Bhopal-462002

2024-25

PROJECT TEAM

The execution of the project work was undertaken with the help of following team constituted for the purpose:

Field Investigator	Principal Investigator
Ms. Urvashi Chitransh Shrivastava	**Dr. Shivalika Sarkar**

CONTENTS

Chapter III
RESEARCH METHODOLOGY

PREFACE

Our civilization is facing a time of unprecedented complex, and transboundary sustainable development challenges (Allen et al. 2020). The increased emergence of communicable diseases is linked to an ongoing ecological backlash and declining planetary health (Petrikova et al., 2020, Jowell and Barry, 2020); the rapid degradation of lands, habitat, and biodiversity; growing urbanization; and increasing air pollution that kills millions every year (Cohen et al., 2017). To confront and neutralize such complex global challenges, we cannot continue with standard policy and practices. While the millennial generation is moving from the 21st to the 22nd century, instead of awaiting, we should consciously create a future without poverty and hunger, with sustainable jobs, and a clean environment, that requires deep transformational changes in how our economies and societies function if we are to achieve the SDGs (Sachs et al., 2019).

Hence, it is high time to look beyond the GDP, in understanding quality of life. The gamut of research globally, including India, have provided alternative metrics to measure development progress. These indices are both qualitative and quantitative and emphasize how human needs for food, shelter, healthcare, friendship, and a healthy ecosystem are met. Similarly, it is high time to redefine education. The education for the solution of societal problems by science and technology, more clearly speaking by the intersection of science and social science. Extreme heat events, wildfires, droughts and floods, infectious diseases, and food availability and nutrition are all inextricably linked to climate and how humans and animals interact. For instance, one-third of heat-related deaths can be attributed to climate change (Lüthi et. al. 2023). In the context of the climate crisis, an urgent need is felt for clear, compelling communication to better educate the public about climate change, encourage behavior change, and need concerted efforts interconnected solutions through innovations and entrepreneurship. Policymakers need to work with academics and trusted indigenous knowledge of local communities to tackle local problems that are global in nature.

Science and technology are the most powerful agents of change, but the judicial exploration of the full potential of science and technology depends on actors, including researchers and engineers, technocrats, doctors, entrepreneurs, financiers, policymakers, educators (Messerli et al., 2019). The stakeholders need to find a common language and modalities for working together to solve problems we encounter. This is only possible if we can educate our future generation who are getting shaped in the classrooms of our schools.

We need education that can apply an interdisciplinary approach in developing strategies to motivate behavior change, tackle misinformation and address inequality in times of crisis and can

provide the best solution in low-cost locally viable technology and practices. Education must be free from an exam-driven nature, free from the burden of marks and grades. Education will definitely be globally comparable, but not merely in terms of PISA or a similar kind of ranking mechanism. India needs an education that is free from colonial hangovers and an education that is deeply rooted in the Indian ethos and Indian system of knowledge and pedagogy. We need education that makes learners learn how to learn and to solve problems to lead a meaningful life.

The rapid evolution of technology is reshaping the educational landscape, influencing how institutions teach, learn, and adapt to emerging trends in educational technology. As educational technologies advance, it is crucial to reflect on current practices while anticipating future innovations. Innovation and creativity are the most important discourse in teaching and learning in this period of time, while we are witnessing the Humancentric Industrial revolution 5.0., where, teachers and learners should negotiate to design learning that is engaging, innovative and collaborative as per the demand of this era of Industrial revolution. Along with students' social and emotional development-oriented teaching strategies in their classrooms, the demanding skills of education 5.0 must be integrated.

The Working Group on Education of the G20, under the presidency of India, has identified priority areas in bridging the gaps in education towards 'the capacity for the future of work' (Compendium, G-20, 2023). NEP-2020 has been designed to cover nearly 500 million children and young adults within its ambit to make future citizens of the country, which is going to lead the global economy. Hence, education must ensure so that learners can adapt the art of learning to negotiate and lead the dynamics of the financial ecosystem. National Curriculum Frameworks for School Education-2023 determines the aim so that learners and teachers can be able to relate to their current realities to transform learning teaching towards critical appreciation to innovations, culminating to entrepreneurship that will be locally resilient and globally relevant.

Under the pretext of the NEP-2020, the Government of India was engaged in conceiving the seeds of a revolutionary education policy in the gestation period of NEP-2020. The National Skill Qualification Framework (NSQF) was published in December, 2013 by the Ministry of Finance that specified an outcome-based approach, national occupational standards and competency-based curriculum packages in compliance with the demands of the industry. Considering the emergence of the integration of Science, Technology, Engineering, and Mathematics in the school curriculum to prepare students for 21st-century skills and bridge the lack of skilled human resources, the concept of "tinkering" has given immense importance in India for innovation and skill development. And the 'Atal Innovation Mission' was introduced in 2016-17 in the form of 'Atal Tinkering Labs', aimed at not only providing space for young minds to collaborate and experiment, but also giving wings to their scientific creativity towards innovations. And further to

that documenting their innovations in the forms of patent and facilitating from prototype to production to ensure connecting lab with the land. Reinforcing entrepreneurial education in schools through ATL would have an instrumental effect on the entrepreneurial dynamism of the national economy. Entrepreneurship education will not only contribute to the creation of social enterprises and business start-ups, entrepreneurship education will make young people more employable and more 'entrepreneurial' in the ongoing changes of work of world, across the social, public and private sectors. After a considerable journey since inception, the ATL project is under public scrutiny and this is the right time to demonstrate the story of success as 'benchmark practices' to further navigate the policy legacy, and also it is the responsibility of stakeholders to assess the limitation of the design of the ATL programme from multiple perspectives for making it more contextual.

For any policy analyst, understanding policy failure is a major challenge and future success depends upon such understanding (Mukherjee, 2024). On the contrary, education policy analysts have not given adequate attention to this issue of why policy filed and what we might learn from it. In many cases, social policy carries a broader symbolic significance than its simple technocratic ends. Now, it is time to go beyond such official business to conform to the 21st century demands of education. The education system is inherently multi-layered, demands different kinds of expertise at each unique layer, and regularly invites political input and divergent administrative interpretations at every stage of implementation of any policy, whether macro, meso or micro level. 'Policy mortality' is a distinctive approach in the field of education policy, as because failure tends to focus on the rationality of policy learning or what can be done better (Dunlop, Citation2020). To maximize policy actualization and minimize policy failure, legitimization beyond the legal framework, policy resourcing and time-bound policy evaluation are the prime strategies that might facilitate effective policy implementation.

So, here, an effort has been made to relook ATL project design and its journey with its merits and limitations with an objective of providing advocacy so that this grand project of NitiAayog could be made more relevant in compliance to the commitment of NEP-2020 and subsequent National Curriculum Framework-2023. The book has selectively chosen eight chapters, each of which reflects pertinent but diverse issues and are in rhythm to the context of the ATL journey. The chapters are written by different authors who were actively engaged in the research process related to the ATL. The first four chapters deal with the policy and pedagogical issues of the ATL projects from critical global and local perspectives. Chpater-5, 6 and 7 address the intricacies of the research findings related to strength, weakness opportunities of the projects along with the benchmark best practices. The stakeholders' perspectives regarding this project are also brought into the ambit of the book. The final chapter has created an open dialogue about the future

orientation of the ATL projects that reflects an intention to provide an overall status and the future direction of ATL in a global and local context from policy perspectives.

This book accommodates diverse theoretical and empirical ideas. The editors are grateful to all contributors for addressing the issues from critical lenses. We do believe that the policymakers, administrators, teachers and other stakeholders may have their tangible takeaways from this edited volume. This book really had no scope to address the all-relevant agenda of ATL-related policy discourse, as Innovation and Entrepreneurship Education is a rapidly growing area in policy design. The policy, Pedagogy and Praxis of entrepreneurship education through ATL has been addressed and hence, this book can provide relevant perspectives for those who are interested in experimenting with the Innovative Education Policy and Programme.

The editors are grateful to the authors. The editors are extremely grateful to the appropriate authority of NitiAayog and RIE, NCERT, Bhopal for granting and facilitating making this book published. We are grateful to those who have silently encouraged us to move forward. At the same time, we must admit that there may be some deficiencies which demand a lot of care that we failed to address and, for that reason, we must be apologetic. Any criticism and suggestions are solicited.

Principal Investigator

ACKNOWLEDGMENTS

First and foremost, we express deepest gratitude to the Honorable Director, NCERT, Prof. Dinesh Prasad Saklani for providing the opportunity to conduct this research.

We would like to express our heartfelt gratitude to the Principal, RIE Bhopal, Prof. Jaydip Mandal for his invaluable guidance, encouragement and unweaving support throughout the research project.

We would like to thank Head DEE, Prof. Chitra Singh for administrative support.

We would like to express our gratitude to the Directors of SCERTs of all states included in the study for providing all necessary support for data collection.

We thank all the resource persons associated with the project for providing constructive inputs in the finalization of tools and also for data analysis.

Special thanks to Mr. Amritanshu Vajpayee, MoC, AIM and Dr. Dhananjay Pandey, Senior Lecturer, Swami Atmanand Multipurpose School, Bilaspur, for their support, and motivation throughout the project.

(Dr. Shivalika Sarkar)

Principal Investigator

LIST OF TABLES

LIST OF FIGURES

Chapter IV
RESULTS and DISCUSSIONS

LIST OF ABBREVIATION

ABBREVIATION	MEANING
AI	Artificial Intelligence
AIM	Atal Innovation Mission
AISECT	All India Society for Electronics And Computer Technology
AR	Augmented Reality
ATL	Atal Tinkering Lab
CAPEX	Capital Expenditure
CBSC	Central Board Of Secondary Education
CGBSC	Chhattisgarh Board Of Secondary Education
CISCE	Council For The Indian School Certificate Examination
CSC	Common Service Centre
DC	Direct Current
DIY	Do-It-Youself
E & C	Electronics & Communications
EDU	Education
EPF	Employees Provident Fund
FGD	Focus Group Discussion
G-20	Group Of 20
G2B	Government To Bussiness
G2C	Government To Citizen
G2G	Government To Government
GBBN	Goa Broadband Network
GBSHSE	Goa Board of Secondary & Higher Secondary Education
GDP	Gross Domestic Product
GER	Gross Enrollment Ratio

GSHSEB	Gujrat Secondary & Higher Secondary Education Board
HSC	Higher Secondary
ICICI	Industrial Credit and Investment Corporation of India
IOT	Internet of Things
ISRO	Indian Space Research Organisation
IT	Information Technology
ITC	Input Tax Credit
LTE	Long Term Evolution
MKCL	Maharashtra Knowledge Corporation Limited
MMR	Mix-Method Research
MOC	Mentor Of Change
MOU	Memorandum Of Understanding
MPBSC	Madhya Pradesh Board of Secondary Education
MSBSHSE	MaharashtraState Board of Secondary & Higher Secondary Education
MS-CIT	Maharashtra State Certificate in Information Technology
NA	Not Available
NCERT	National Council of Educational Research And Training
NCF	National Curriculum Framework
NDLM	National Digital Literacy Mission
NEP	National Education Policy
NFHS	National Family Health Survey
NGO	Non-Governmental Organization
NITI	National Institution for Transforming India
NSQF	National Skills Qualification Framework
OPEX	Operating Expenses
P1	Package 1
P2	Package 2

P3	Package 3
P4	Package 4
PISA	Program For International Student Assessment
PMGDISHA	Pradhanmantri Gramin Digital Saksharta Abhiyan
R	Rural
R & D	Research And Develpment
RIE	Regional Institute of Education
SDG	Sustainable Development Goals
SIP	Student Innovator Program
SKY	Sanchaar Kranti Yojna
SOP	Standard Operating Operation
SSC	Staff Selection Commission
STEAM	Science – Technology – Engineering – Arts – Mathematics
STEM	Science – Technology – Engineering – Mathematics
SWOC	Strength, Weakness, Opportunity, Challenges
U	Urban
UC	Utilization Certificate
VLE	Village Level Entrepreneur
VR	Virtual Reality

EXECUTIVE SUMMARY

Atal Tinkering Labs (ATL), an initiative by the Government of India under the Atal Innovation Mission (AIM), were established with a vision to cultivate an innovative mindset and encourage creativity among young students. ATL aims to foster an ecosystem of innovation and entrepreneurship by providing students with a platform to work on hands-on projects, build prototypes, and develop solutions to real-world problems.One of the main aim of ATL is to promote a culture of innovation and encourage students to think critically, creatively, and to solve problems using technology and design thinking. Through ATL students are provided access to tools and technologies like 3D printers, robotics, and electronics, helping students to learn by doing. ATL also aims to develop a strong foundation for entrepreneurship: Nurturing young minds to create solutions and transform them into viable products or services, promoting a spirit of entrepreneurship.It is one of the significant initiatives the Government of India launched in 2016-2017. Aims of Atal Tinkering Labs is to foster twenty-first-century skills such as creative thinking, critical thinking, problem-solving skills, design thinking, innovation, and entrepreneurship skills among young students that enable them to address the complex challenges in this decade. Atal Tinkering Labs incorporates technology and promotes STEM (Science, Technology, Engineering, Mathematics) education and fosters scientific temper among young minds. The Atal Tinkering Labs provides a great learning experience by offering experiential or hands-on learning experiences and an interdisciplinary approach. The Atal Tinkering Labs foster or embrace a new curriculum approach that talks about new ways of engagement and interaction with content that aligns with the needs of twenty-first-century challenges.

Objectives and Data Sources

The study aimed to fulfill the following objectives:

a. To study the status of the use of ATL in Secondary Schools of Western Region in India, i.e. the study area.
b. To study the effectiveness of ATL in achievement of Learning Outcomes of Secondary School students of the study area.
c. To study the effectiveness of ATL in promoting key 21stcentury skills, viz. Creativity, Innovation, Entrepreneurship, Critical thinking, and Design thinking among Secondary Schools students of the study area.
d. To explore the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) associated with the implementation of ATL in Secondary Schools of the study area.

e. To identify the best practices associated with ATL.

f. To suggest a framework for better implementation of ATL in Secondary Schools of the study area and to provide inputs to ATL Sarthi Scheme

FINDINGS FOR OBJECTIVE - 1

Objective 1- To study the status of the use of ATL in Secondary Schools of Western Region in India, i.e. the study area

The analysis of usage of Atal Tinkering Lab (ATL) across various states in western India reveals significant trends in both rural and urban schools from student's perspective. Urban schools in Chhattisgarh exhibit the highest daily usage of ATL, with many students participating weekly. Most students engage in ATL activities for 1-2 years, benefiting from consistent support from ATL in-charges. Accessibility to ATL facilities outside school hours is notably high in rural Madhya Pradesh. A strong interest in science and technology emerges as the primary motivational factor for participation, positively influencing students' career choices and reinforcing the role of ATL in promoting STEM education. Over the last decade, substantial investments in STEM infrastructure and curricula have been made by both public and private sectors, recognizing the importance of STEM fields for innovation and economic growth.The analysis of data from ATL (Atal Tinkering Lab) in-charges reveals a high availability of essential tools and equipment in schools. This infrastructure supports STEM integration. Student engagement in ATL programs is structured but varies by interest, with high participation in workshops and seminars, but lower involvement in industry visits and specific programs like AIM Hackathon. Additionally, ATL positively influences career prospects, urban respondents finding it more effective compared to that of rural areas. Private schools view ATL more favorably than government schools, private school ATL in-charges reporting more effective integration and a stronger perceived impact on educational outcomes as compared to government schools. This disparity suggests that funding differences may affect the performance of government schools in ATL initiatives.

FINDINGS FOR OBJECTIVE - 2

Objective 2- To study the effectiveness of ATL in achievement of Learning Outcomes of Secondary School students of the study area

The analysis reveals that rural students outperform urban students in high achievement, although moderate scores are prevalent in both groups. This suggests that while ATL has a stronger impact in rural areas, interventions are necessary to improve overall academic performance.The findings indicate that government schools report higher high scores compared to private schools. The data highlights systemic inequities, particularly in private schools in Goa and Gujarat. •The overall distribution of scores shows a predominance of moderate performance, indicating that while ATL fosters foundational competencies, it is less effective in cultivating advanced mastery. The absence of a "Very High" category limits the assessment of top performers. The chapter concludes that differentiated instruction and advanced modules are needed to support high-potential learners, and further investigation into the factors contributing to rural students' higher performance is warranted.

FINDINGS FOR OBJECTIVE – 3

Objective 3 – To study the effectiveness of ATL in promoting key 21stcentury skills, viz. Creativity, Innovation, Entrepreneurship, Critical thinking, and Design thinking among Secondary Schools students of the study area.

The performance of students in design thinking assessments, revealing a significant concern: more than half of the students falling into the low skill category, and a very few achieving high scores. This trend indicates a critical deficit in creative design thinking skills, essential for 21st-century education.The findings emphasize the need for strategic interventions to enhance design thinking competencies, particularly by replicating successful mentorship models from Gujarat in low-performing states like Maharashtra.

Results of entrepreneurship skills among secondary school students in the Western Region, reveal majority of students possess moderate skills, indicating a foundational understanding but a lack of advanced competencies, with very few achieving high scores. Urban students outperform rural students in high achievement, while rural students excel in the moderate category. Variations based on school management types show that government schools have more low-achieving

students, while private schools perform better in the moderate category. State-wise, Gujarat's rural schools demonstrate strong foundational skills, while Maharashtra's urban schools lead in high achievers. Overall, the assessment indicates a significant gap in advanced entrepreneurial skills, emphasizing the need for improved integration of design thinking and entrepreneurship in academic subjects to address these disparities.

FINDINGS FOR OBJECTIVE - 4

Objective 4 - To explore the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) associated with the implementation of ATL in Secondary Schools of the study area

Atal Tinkering Labs (ATLs) are engaging students in technology through hands-on experimentation with tools like electronics and robotics, enabling them to address local and global challenges. These labs foster critical competencies such as creativity, curiosity, and innovation while promoting skills like design mindset, computational thinking, and adaptive learning, leading to overall student development.

•For teachers, ATLs enhance personal and professional development by exposing them to new technologies and concepts, thereby enriching the learning environment for both students and educators. This initiative encourages inclusive and engaging classrooms that nurture creativity and problem-solving skills.

•The effectiveness of the Atal Tinkering Lab (ATL) program is hindered by several factors. Firstly, a lack of knowledge among ATL in-charges regarding content, curriculum, and teaching methodologies affects program outcomes, especially in less motivated schools. Additionally, the engagement of Mentors of Change (MOCs) is minimal, with most schools not benefiting from their support, either in-person or online. Students struggle to integrate ATL with their regular curriculum, viewing it as a separate entity rather than a cohesive part of their learning. Furthermore, adequate support from schools, including resources and time, is crucial for the program's success, yet many schools fall short in this area. Finally, the absence of consistent assessment and research limits the ability to monitor student performance and overall program effectiveness, leading to varied implementations across different ATLs.

•The management of Atal Tinkering Labs (ATLs) is increasingly challenging for teachers, particularly in secondary schools, due to several factors. Time management issues arise when no additional periods are allocated for ATL, forcing teachers to conduct sessions after school, which not all students can attend. Financial constraints hinder the procurement of necessary consumables for proper ATL functioning. Mentor support is limited, with only a few assigned mentors actively

providing assistance. Additionally, motivating students to continue with ATL amid academic pressures is difficult, leading many to discontinue participation. There is also a significant gender disparity in participation rates between boys and girls.

•The educational qualifications of ATL in-charges affect the labs' effectiveness, highlighting the need for qualified personnel. The interrelation of strengths, weaknesses, opportunities, and challenges within ATLs is emphasized, with opportunities being created through innovative thinking and persistence. Successful ATL initiatives rely on the dedication and enthusiasm of in-charges, who often seek to enhance their skills for the benefit of their students.

•ATLs promote various learning methodologies, including game-based and project-based learning, while connecting theoretical knowledge to real-world applications. They prioritize understanding students' psychological needs by minimizing the pressure of quantitative assessments. The initiative focuses on cognitive, affective, and psychomotor domains, fostering a hands-on learning environment and introducing design thinking for innovative solutions. By recognizing achievements at various levels, ATLs aim to cultivate 21st-century skills and minimize challenges through a clear analysis of their strengths and opportunities.

FINDINGS FOR OBJECTIVE –5

Objective 5 - To identify the best practices associated with ATL.

The generic best practice is hands-on based experiential learning that where students actively engage in designing, prototyping, and problem-solving using most effective modern tools this fosters creativity, critical thinking, and design-based learning. In general mentorship program, peer learning and collaboration and community engagement by addressing the common people's challenges the ATL is unique in nature. The best practices studied collectively ensure that ATL projects nurture a culture of innovation, entrepreneurial thinking, and problem-solving among students, preparing them to thrive in the 21st-century knowledge economy.The best practices presented in this chapter have their own particular experiences but all of them have been able to facilitate student learning and skill development through ATL. Other schools may adapt these best practices to transform their ATL into a more dynamic place of learning and innovation. These best practice models can serve as a guide to teachers who wish to promote innovation, problem-solving, and entrepreneurship through ATL. These practices can be further refined by the teachers and school management to build an ecosystem of young innovators, problem solvers and global

citizens. To scale and sustain the ATL initiatives these best practices can show a pathway to the policy makers to ensure maximum utilization of ATL.

FINDINGS FOR OBJECTIVE –6

Objective 6 - To suggest a framework for better implementation of ATL in Secondary Schools of the study area and to provide inputs to ATL Sarthi Scheme

ATL activities should be integrated as part of the curriculum in schools and should not be treated as an extra activity. At present, in most schools, it is left to the choice of the students to participate in ATL activities or not. Teachers can effectively integrate the ATL activities into the existing curriculum through proper training. For this, there will be a need to strengthen ATL teacher training programs. This will remove the extra burden of ATL activities and ensure maximum participation of the students. Also, students may be encouraged to take up interdisciplinary projects through dedicated sessions allocated in the timetable. A National ATL Mentor Program can be taken up by the government to train students on various aspects of project making. ATL will be a major place of learning, innovation and skill development where students are involved in real world projects by collaborating with local businesses, farmers, hospitals, and NGOs. All projects should be based on a design-thinking approach to promoting innovation and centered on solving community problems. To convert ATL from a tinkering space to an incubation center for student startups, there will be a need for more Industry-Academia collaboration, following a research and development approach in executing all projects along with design-thinking integration, leveraging emerging technologies, fostering a culture of experimentation and establishing an ATL Alumni Network. Training modules can be made to train teachers in developing 21st century skills such as creativity, collaboration, problem-solving, critical thinking, and communication skills in learners through ATL activities. Apart from developing practical skills in learners, socio-emotional skills can also be promoted through ATL. NEP 2020 emphasizes Socio-Emotional Learning (SEL) as a crucial component of holistic education. It recognizes that social and emotional skills are essential for students' overall development and success in life. ATL projects can include design thinking exercises, teamwork-based challenges, and community impact initiatives to enhance SEL. Encouraging students to work on social entrepreneurship projects can strengthen their empathy, resilience, and leadership skills. There is a need to identify potential ATL projects that can be converted into marketable products. ATLs need to partner with local businesses, e-commerce platforms, and startup incubators to sell

student-designed products. ATL may be developed as a technology testing ground for industry innovations. The ATL Lab in future should contribute to India's economy. Aligning ATL projects with Make in India, Digital India, and Startup India can enhance their impact. India can aim to become a $500,000 trillion economy and ATLs can play a crucial role in building a strong foundation for innovation-driven growth. Also, there will be a need to have more inclusive and equitable education through ATL and promotion of sustainability and climate resilient engagement through ATL.

ANNEXURES

ANNEXURE A: Students' feedback on uses of ATL

ANNEXURE B: Students achievement test

ANNEXURE C: A creative design thinking scale was administered to collect the data andthe five-point questionnaire used for expressing the entrepreneurship skills.

ANNEXURE D: Scheduled type questionnaire administered to the ATL in-charge

ANNEXURE E: Interview schedule used to explore the SWOC

ANNEXURE F: Teaching learning in ATL

ANNEXURE G: Lab observation schedule

ANNEXURE H: Illustrative list of equipments in ATL

ANNEXURE I: Workshops conducted for the research project

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

With a vision to 'Cultivate one Million children in India as Neoteric Innovators', Atal Innovation Mission is establishing Atal Tinkering Laboratories (ATLs) in schools across India. The main objective of this scheme is to empower youth with the 21 century skills of creativity, innovation, critical thinking, design thinking, social and cross-cultural collaboration, ethical leadership and so on. National Education policy 2020 also envisages creating holistic and well-rounded individuals equipped with the key 21st century skills. According to NEP 2020 there is a need to articulate new directions for research and innovation. As part of the pursuit of spreading the dual features of innovation and entrepreneurship, children are introduced to technology innovation by establishing Atal Tinkering Lab (ATL) in the schools of India. The aim is to meet the creativity of the students with imagination and develop a problem-solving attitude in the society with the inclusion of STEM Education. 10,000 schools in more than 680 districts around the nation have already been chosen by AIM for the creation of ATLs. Over 2 million children have access to ATLs, and over 7000 schools have received funding to date. India as a nation will be able to prosper in a holistic manner when the fruits of development trickle down to the grass root level in an even manner for all the sections of the society. In such a scenario, ATLs have the power to attract the imagination of students from different strata of the society irrespective of the availability of the resources in the local society. ATLs are definitely a boon especially for cultivating the process of innovation among the children hailing from tribal and interior regions of India as well. ATLs were established to cater to the following domains: to design environments where young minds can gain innovative skills, shape concepts via practical exercises, and work and learn in a flexible setting, to provide our young people with the abilities necessary for the 21st century. The socio-economic situation heavily influences the availability of the options of academic, social and economic growth of a region. It is evident to improve R & D (Research and Development), Innovation and Entrepreneurship; an institutional push is need for the emancipation of the next generation. In this regard, the establishment of ATLs can prove to be a milestone if implemented and utilized properly. This is can be achieved if ATLs work on the philosophy of experiential learning, no-cost/low-cost activities, design thinking, social learning. Atal Tinkering lab offers advanced features of technology to students that utilize this technology to invent something new. Thus, tinkering lab that has a curriculum aligned with NEP 2020 that teaches students from basic to advanced level skills.It not only helps the students to learn the real-life application and importance of the theories they have learned from their books but will also develop a natural affinity towards STEM. In fact, science is something to be "felt and experienced" rather than reading and learning.

The 21st century has witnessed a paradigm shift in education, with an increasing emphasis on STEM (Acronym for: Science, Technology, Engineering and Mathematics) and innovation-driven learning. The dynamics of the education is as such that in quite a short span of time, the STEM education has paved way for STEAM (Science – Technology – Engineering – Arts – Mathematics) form of learning. Globally, the maker movement and STEM/STEAM – based learning environments have gained prominence. Countries such as the United States, Germany, and Singapore have integrated hands-on learning spaces into their education systems to promote innovation. Traditional education systems, which primarily focus on theoretical knowledge, often fail to develop problem-solving and creative thinking skills essential for the modern workforce. In the contemporary era, the global economy is increasingly driven by innovation and technology. To remain competitive, nations must invest in fostering a culture of innovation from an early age. Recognizing this need, the Government of India, under the leadership of NITI Aayog, launched the Atal Innovation Mission (AIM) in 2016. One of the flagship initiatives under AIM is the establishment of Atal Tinkering Labs (ATLs) in schools across the country.

Inspired by global trends in STEM education, ATLs aim to bridge the gap between theoretical knowledge and practical application. The vision behind the program aligns with India's broader goal of developing a knowledge-driven economy. ATLs are designed to provide students with a platform to explore, experiment, and innovate. By equipping students with 21st-century skills such as critical thinking, problem-solving, and design thinking, ATLs aim to transform the traditional education system and prepare students for the challenges of the future.

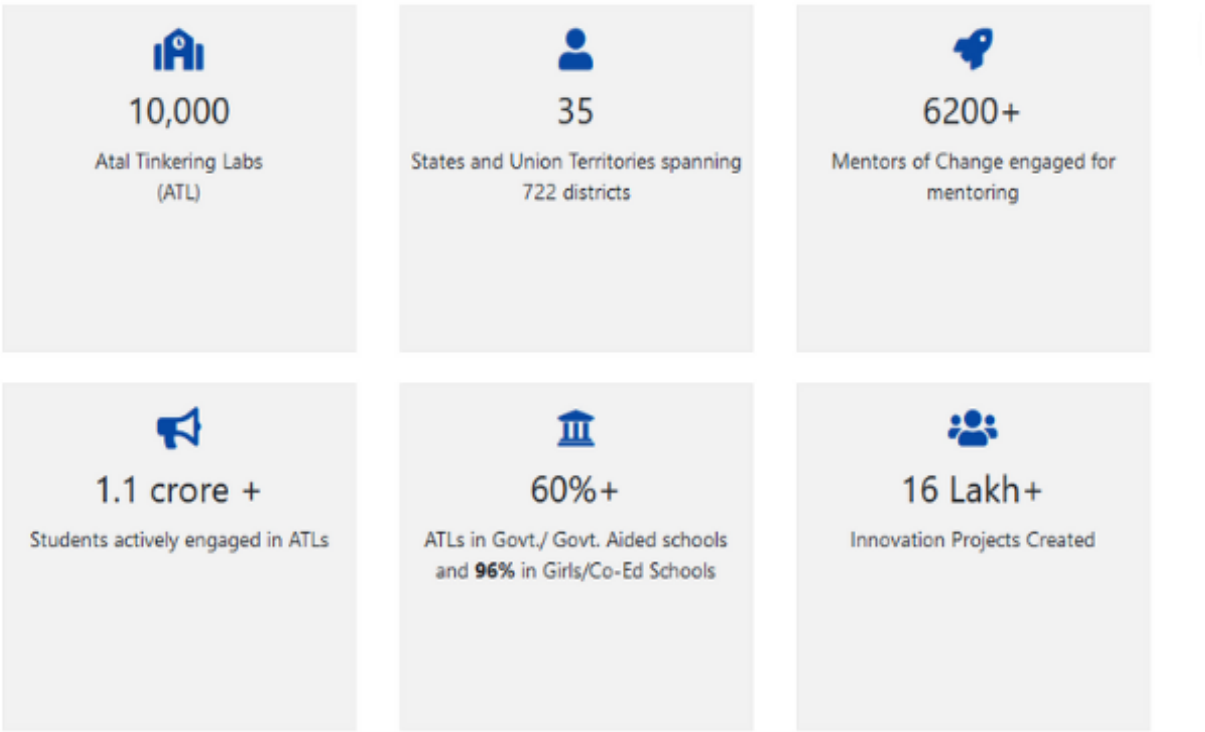


Figure 1.1: Some vital info-graphic statistics about Atal Tinkering Labs, India

According to Global Innovation Index Ranking, India ranks at the sixth position, from 66th in 2016 to 60 in 2017, out of 127 countries.

First Atal Tinkering Lab

The first Atal Tinkering Lab is all set to welcome its first set of tinkerers at Salwan Government Girls' School, Delhi.

This lab has been set up with support of Intel as part of a mutually signed collaborative initiative. The objective is to develop 10 of the selected schools as state hubs and empower them to provide support to all the ATLs.

Atal Tinkering Lab Adoption by ISRO-

Department of Space, ISRO adopted 100 Atal Tinkering Labs (ATLs) across the country to promote education in the field of STEM, Space education and Space technology related innovations for school students.

With adoption of 100 ATLS, distributed geographically in line with ISRO's presence across the country in the form of various centers, the organization is taking a small step in engaging with the students, towards giving them direction in pursuing their space dreams as a part of 'Atma Nirbhar Bharat'. Scientists and engineers from ISRO centers, in close coordination with Capacity Building Program Office, ISRO Headquarters. ISRO senior scientists from ISRO centres will actively mentor the kids as well as interact with teachers in these ATLs encouraging experiments, brainstorming ideas and spreading awareness about outer space activities.

AIM (Atal Innovation Mission) provides a grant-in-aid of ₹20.00 lakh for establishing an Atal Tinkering Lab (ATL). This comprises a one-time establishment charge of up to ₹10.00 lakh in the first year. This initial funding is allocated for acquiring instruments, prototyping equipment, including do-it-yourself kits, 3D printers, electronic tools, etc. The remaining ₹10.00 lakh is distributed over a maximum period of 5 years, covering operational expenses such as equipment maintenance, purchase of consumables, organization of science lectures, innovation events, scientific activities, competitions, and payment of honorariums to faculty and mentors involved in the ATL.

After obtaining the ATL grant, the school is required to follow a specific procedure for setting up the Atal Tinkering Lab (ATL) within three months of acquiring the grant and adhering to the guidelines.Once selected, the schools will have to utilise the funds to purchase tinkering kits as suggested in the AIM guidelines namely- P1, P2, P3,P4.

Equipment Procurement:

Purchase equipment based on the ATL Equipment lists provided by NITI Aayog.

The necessary equipment is categorized into four packages: P1 for Electronics Development, Robotics, Internet of Things, and Sensors; P2 for Rapid Prototyping Tools; P3 for Mechanical, Electrical, and Measurement tools; and P4 for Power Supply, Accessories, and Safety equipment.

Schools can refer to the resources on http://aim.gov.in/resources.php to understand the components and equipment.

NITI Aayog has given the responsibility to vendors to setup ATLs in schools. TECHB, one of the vendors has been providing tinkering equipment to schools along with providing the training.

Certified ATL Packages Product

Figure 1.2: Atal Tinkering Lab Package No. 1 of Niti Aayog Electronics Development, Robotics, Internet of Things and Sensor

Figure 1.3: Atal Tinkering Lab Package No. 2 of Niti Aayog Rapid Prototyping Tools

Figure 1.4: Atal Tinkering Lab Package No. 3 of Niti Aayog Mechanical, Electrical and Measurement Tools

Figure 1.5: Atal Tinkering Lab Package No 4 of Niti Aayog Power Supply and Accessories And Safety Equipment

Figure 1.6: Top Skills

Four Levels of Tinkering

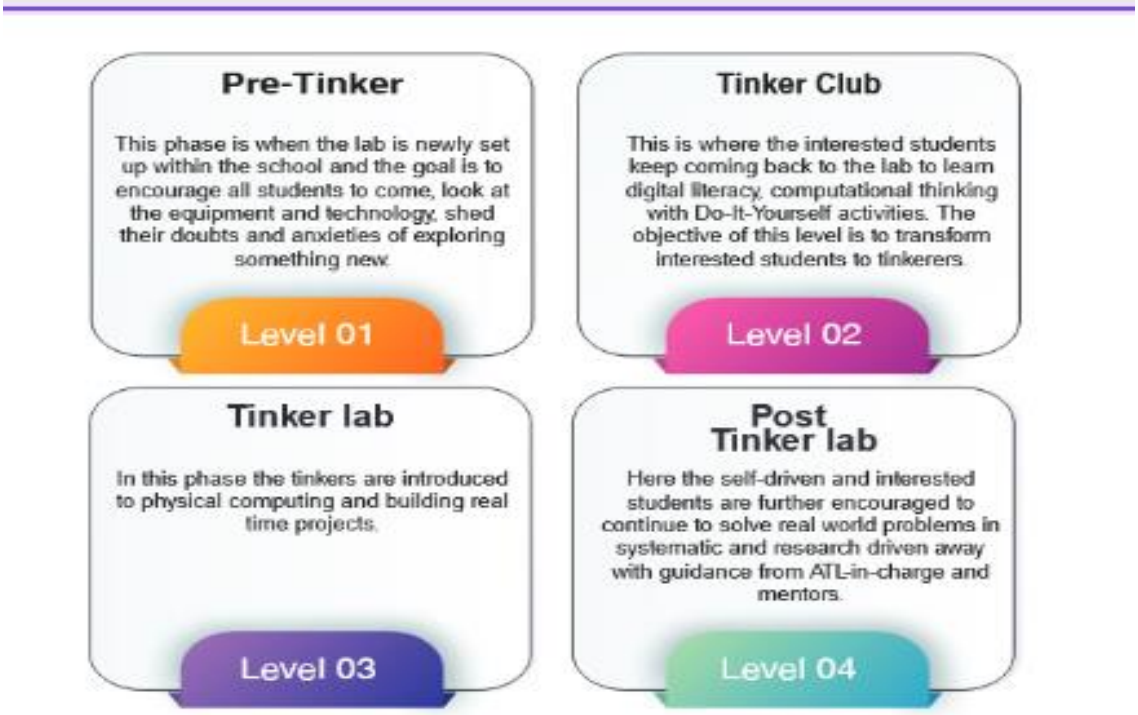


Figure 1.7: Four Levels of Tinkering

What's the goal?

To encourage students to be curious, creative, and imaginative
To help students develop skills like critical thinking, design thinking, and computational thinking
To help students learn about STEM concepts through hands-on activities
To help students develop an entrepreneurial mindset
To help students bridge the gap between theoretical and practical learning

How are ATLs set up?

ATLs are part of the Atal Innovation Mission (AIM)
The National Institution for Transforming India (NITI Aayog) administers the scheme
ATLs are set up in schools across India

What's included in ATLs?

3D printers
Open-source microcontroller boards
Sensors
Computers
Do-it-yourself kits
Electronic kits
Arduino boards

Who can use ATLs?

Schools with a minimum area of 1,500 sq ft (in all-weather area) are eligible to apply.

The ATL initiative presents several opportunities for India's education system. By fostering a culture of innovation and creativity, ATLs have the potential to transform the way students learn and prepare them for the challenges of the 21st century. The success of ATLs could serve as a model for global STEM education initiatives. The programme's ability to nurture young innovators can contribute to India's position as a leading knowledge economy. Future expansions should focus on inclusivity, bridging the urban-rural divide, and incorporating emerging technologies.

1.2 RATIONALE OF THE STUDY

The rapid advancements in technology and the evolving job market demand a shift in educational approaches to equip students with essential 21st-century skills such as critical thinking, creativity, collaboration, and problem-solving. The Atal Tinkering Labs (ATL) initiative, launched under the Atal Innovation Mission (AIM) by NITI Aayog, aims to foster a culture of innovation, hands-on learning, and STEM education among school students. However, there is a need for empirical research to assess the actual impact of ATL on students' learning outcomes and on promoting 21st century skills. This study is crucial to determine. ATL promotes experiential and inquiry-based learning, which could significantly improve students' conceptual understanding in STEM subjects. Evaluating ATL's influence on academic performance and problem-solving skills will provide insights into its educational value. Promotion of 21st-Century Skills – ATL encourages students to work on real-world challenges using design thinking, robotics, AI, and IoT tools. Investigating its role in fostering creativity, collaboration, communication, and digital literacy will help understand how well it aligns with global education trends. Bridging the Innovation and Entrepreneurship Gap – By offering hands-on exposure to technology and innovation, ATL can potentially nurture an entrepreneurial mindset among students. This study will assess whether ATL participants demonstrate higher entrepreneurial intent and innovation capabilities. The findings of this research can guide educators, policymakers, and institutions in refining ATL implementation, integrating tinkering methodologies into mainstream curricula, and scaling similar initiatives to enhance STEM education nationwide. Given the pressing need to align education with future workforce requirements, this study will provide valuable evidence on the effectiveness of ATL in fostering innovation-driven learning, making it a critical area for research and policy intervention.

1.3 OBJECTIVES OF THE STUDY

a. To study the status of the use of ATL in Secondary Schools of Western Region in India, i.e. the study area.
b. To study the effectiveness of ATL in achievement of Learning Outcomes of Secondary School students of the study area.
c. To study the effectiveness of ATL in promoting key 21stcentury skills, viz. Creativity, Innovation, Entrepreneurship, Critical thinking, and Design thinking among Secondary Schools students of the study area.
d. To explore the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) associated with the implementation of ATL in Secondary Schools of the study area.
e. To identify the best practices associated with ATL.
f. To suggest a framework for better implementation of ATL in Secondary Schools of the study area and to provide inputs to ATL Sarthi Scheme

1.4 CONCEPTUAL FRAMEWORK

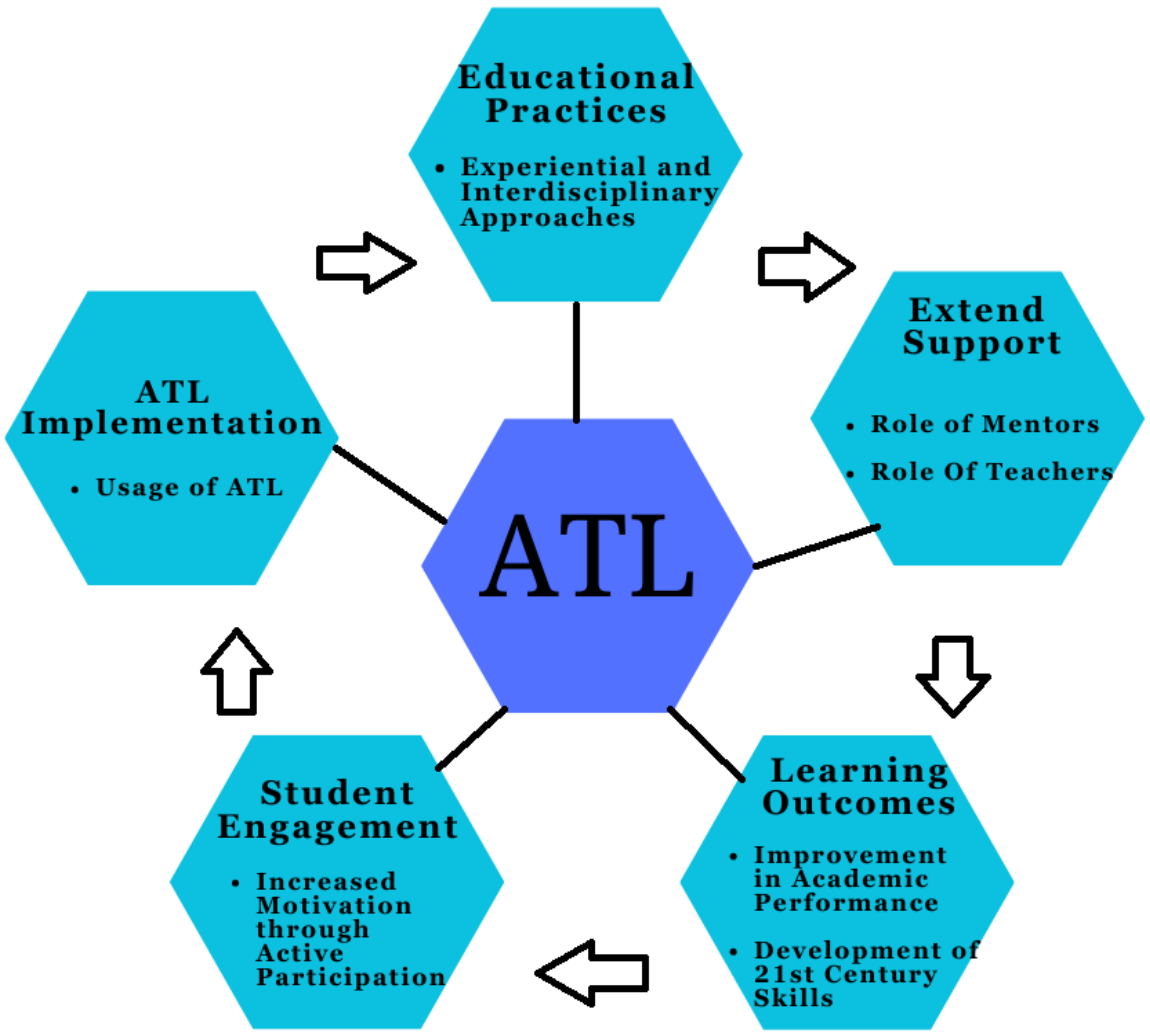


Figure 1.8: Conceptual Framework

CHAPTER 2

AN OVERVIEW OF THE ATAL TINKERING LABS (ATLs)

2.1 ABOUT THE ATAL TINKERING LABS

Atal Tinkering Labs (ATLs) are an initiative by the Government of India under the Atal Innovation Mission (AIM), launched byNational Institution for Transforming India, also called NITI Aayog in 2016. Atal Innovation Mission (AIM) is the Indian Government's flagship program to foster a culture of entrepreneurship and innovation. The Atal Tinkering Labs (ATLs) sub-scheme of AIM involves setting up laboratories in schools across the country to conduct activity-based learning. The laboratories provide mentorship and guidance to students via the Mentor of Change (MoC), and ATL In-Charge, a volunteers-driven initiative by AIM. An Atal Tinkering Lab is a dedicated innovation and experimentation space within Indian schools. ATL is a workspace where young minds can give shape to their ideas through hands on learning mode and learn innovation skills. Young children's (typically from Class 6 to 12) will get a chance to work with tools and equipments to understand the concepts of STEM (Science, Technology, Engineering and Math). ATL would contain educational and learning 'DIY (Do-It-Yourself) Kits and Tinkering and Prototyping Tools such as 3-D printers, microprocessors, robotics kits, sensors, motors, drillers, cutters, Arduino, Raspberry PI, Internet of Things (IoT) Tools, Artificial Intelligence, coding and other resources etc. ATL is an approach to empower our youth with the 21st century skills of creativity, innovation, critical thinking, problem solving, design thinking, social and cross-cultural collaboration, ethical leadership and so on. Through this approach students will able to develop their problem-solving skills, encourages innovation and creativity and improves their collaboration and teamwork skills. ATL provides a platform for students to showcase their ideas and bridge the gap between theoretical knowledge and practical application.Students can also participates in national and global competitions, problem-solving workshops, exhibitions, designing and fabrication of products, lectures, and so on, and showcasing their creative projects. Students can also participate in ATL Marathons, Innovation Challenges, Hackathons, Ideathons etc. ATL exposure not only validates students' ideas but also opens doors to collaborations and mentorships which includes industry experts, entrepreneurs, academicians, engineers, and scientists who mentor the students to apply their ideas and develop innovative projects, so that students can create a pathway for their innovations to make a meaningful impact on society. ATL inspire students to become future entrepreneurs and technologists and support grassroots innovations that solve real-world problems.

Through the Atal Tinkering Labs (ATL), AIM is fostering innovation at school level, where students get anopportunity to experience design thinking and widen their intellectual horizons in pursuit of solutions to day-to-dayproblems and showcase their innovations at prestigious platforms. The goals and vision of the ATL program ties in beautifully with the National Education Policy and will play a pivotal role to implement Experiential and Project-Based

Learning model in india. The ATL ecosystem in a school facilitates a fresh learning-by-doing teaching and learning methodology. This keeps both the teacher and the student engaged and excited. The 21st century needs a radical and disruptive change to a student's learning processes, with each passing day; new technology interventions by the industry are challenging the education system to create Future-ready Makers. Tinkering and Making are natural human skills which now need to be embraced with technology.

Beyond academic excellence, Atal Tinkering Labs nurture an entrepreneurial spirit among students. Atal Tinkering Lab go beyond the immediate goal of school education, they create a foundation for lifelong learning. The labs provide a platform for students to explore their business ideas, create prototypes, and understand the fundamentals of entrepreneurship. ATL not only prepares students for potential future ventures but also instils a mindset of innovation and risk-taking- a crucial aspect of entrepreneurial success.Further, the support of students, teachers, principals and parents is considered crucial in successfully achievingthe objectives of ATL. The overall goal is to disrupt the Indian education system, and create an army of younginnovators ready to take on the further challenges, in their constant pursuit to build the New India.As these labs continue to flourish, they light the torch of innovation, illuminating a path towards a future where creativity knows no bounds. Through Atal Tinkering Labs, India is not just nurturing students; it is nurturing the innovators and problem solvers who will lead the way to a brighter tomorrow.

ATL Eligibility

Government and private schools (from Class 6-12) can apply for ATL funding under NITI Aayog's scheme. Under the ATL scheme, grant-in-aid of up to 20 lakh is provided to schools selected for setting up an ATL. Thegrant must be spent exclusively for the specified purpose within the stipulated time of a maximum period of 5 years,with Rs.10 lakh for capital expense and remaining Rs.10 lakh for operational and maintenance expenses.

Impact & Growth

- Over 10,000+ ATLs established in schools across India.
- Encourages interdisciplinary learning and early-stage entrepreneurship.
- Supports national initiatives like Make in India, Digital India, and Startup India.
- Promoted grassroots innovation with thousands of student-led projects in diverse fields like agriculture, health, education, and environment.

Background

Vision: To create a culture of scientific curiosity and innovation in young minds.

Mission: To provide students with access to advanced technologies like 3D printing, robotics, AI, IoT, coding, enabling hands-on learning and to empower the youth with the 21st century skills.
Target Group: School students from Grades 6 to 12 in both urban and rural areas.

The ATL program design and implementation follows a plug and play approach and includes standard guidelines, curriculum, training tools, standard operating procedures (SOP) and is supported by a robust IT system and several partnerships. It enables the creation of a culture of innovation and a vibrant collaborative ecosystem within the school community, through celebration and recognition of innovative students, teachers, mentors, parents and other stakeholders.

This research focuses on evaluating the effectiveness of the ATL initiative in promoting 21st century skills among secondary school students. It also includes the study of effectiveness of ATL in achievement of learning outcomes at the secondary stage and explores the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) associated with the implementation of ATL in Secondary Schools of the study area. This research identifies the best practices associated with ATL and suggesting a framework for better implementation of ATL.

2.2 STUDY AREA PROFILE

2.2.1 CHHATTISGARH

Educational Profile of Chhattisgarh

Chhattisgarh, established as a state on November 1, 2000, has been working to enhance its educational infrastructure and literacy rates. Here's an overview of the state's educational profile:

Literacy Rate:

According to the 2011 Census, Chhattisgarh had an Education Index of 0.526, which was higher than that of Bihar, Jharkhand, Uttar Pradesh, and Rajasthan (en.wikipedia.org)

The average literacy rate in urban regions was 84.05%, with male literacy at 90.58% and female literacy at 73.39% (en.wikipedia.org)

School Education:

The state follows the 10+2 pattern of education, with both private and government-run schools(en.wikipedia.org) . Government schools are typically affiliated with the Chhattisgarh Board of Secondary Education (CGBSE), established on September 20, 2001, responsible for promoting and developing secondary education(en.wikipedia.org). Private schools often affiliate with national boards like the Central Board of Secondary Education (CBSE) or the Council for the Indian School Certificate Examinations (CISCE) (en.wikipedia.org)

Challenges and Initiatives:

Despite progress, challenges remain, particularly in tribal regions like Bastar and Dantewada, where literacy rates are lower, and dropout rates are higher (en.wikipedia.org)

Organizations such as the Ramakrishna Mission Ashrama in Narainpur are actively working to uplift and educate tribal populations in remote areas (en.wikipedia.org)

Chhattisgarh continues to focus on improving its educational landscape, striving to provide quality education and address regional disparities.

Educational Administration of Chhattisgarh:

Chhattisgarh Board of Secondary Education (CGBSE):

Formed after the state's establishment in 2000, CGBSE is responsible for the promotion and development of secondary education in Chhattisgarh. Its primary functions include:

Conducting examinations for Class 10 and Class 12.

Granting affiliations to schools.

Prescribing curricula and textbooks.

Training educational professionals.

Regional Support:

Both states benefit from the Regional Institute of Education (RIE) Bhopal, a constituent unit of the National Council of Educational Research and Training (NCERT). Established in 1963, RIE Bhopal caters to the educational needs of states including Madhya Pradesh and Chhattisgarh, focusing on qualitative improvement of school education through innovative pre-service and in-service teacher education programs, research, development, and extension activities (en.wikipedia.org) .This structured approach ensures that both Madhya Pradesh and Chhattisgarh maintain organized educational systems, aiming for continuous improvement and accessibility in education.

Digital Literacy ofChhattisgarh

Digital literacy in Chhattisgarh reflects a blend of initiatives and challenges, particularly concerning gender disparities and rural-urban divides.

Government Initiatives:

Under the National Digital Literacy Mission (NDLM), Chhattisgarh has made significant progress. As of November 2022, the state reported the following figures:

Enrolled: 312,370 individuals

Trained: 231,036 individuals

Certified: 146,451 individuals (Indiastat)

Gender Disparities:

Chhattisgarh exhibits a notable gender gap in internet literacy. The disparity score stands at 29.6, indicating a significant difference between male and female internet usage rates (SAS Publishers)

Sanchaar Kranti Yojana (SKY):

To address digital gender gaps, the Chhattisgarh government launched the Sanchaar Kranti Yojana (SKY) in 2018. This initiative aimed to distribute over 2 million free smartphones to female household heads, alongside constructing LTE towers to enhance high-speed data coverage. Despite these efforts, studies indicate that while smartphone ownership among women increased initially, there was no long-term impact on closing digital gender gaps (egc.yale.edu)

Educational Context:

The COVID-19 pandemic highlighted challenges in digital literacy within higher education in Chhattisgarh. Students faced difficulties adapting to online learning platforms, underscoring the need for improved digital skills training (researchgate.net)

These insights underscore the ongoing efforts and challenges in enhancing digital literacy in Chhattisgarh, emphasizing the need for targeted interventions to bridge existing gaps.

Digital Inclusion ofChhattisgarh

Chhattisgarh has implemented several innovative initiatives to promote digital inclusion, particularly in its rural and tribal regions.

Bultoo Radio:

Launched in 2015 by CGNet Swara in collaboration with the state government, Bultoo Radio leverages Bluetooth technology to disseminate news and entertainment content in areas lacking traditional media access. This service enables residents to share and receive information in local languages, fostering community engagement and awareness (en.wikipedia.org)

CGNet Swara:

Established in 2010, CGNet Swara is a voice-based online portal that allows individuals in Chhattisgarh to report local news by making a phone call. These reports are moderated by journalists and made accessible both online and via mobile phones, providing a platform for rural communities to voice their concerns and share information (en.wikipedia.org)

Common Service Centres (CSCs):

As part of the national Digital India initiative, CSCs serve as access points for various digital services in rural areas. They offer services such as e-governance, financial inclusion, and digital literacy programs, thereby enhancing digital access and literacy among rural populations (en.wikipedia.org)These initiatives collectively contribute to bridging the digital divide in Chhattisgarh.

2.2.2 GOA

Educational Profile of Goa

Goa has made significant progress in the field of education, achieving high literacy rates and establishing reputable institutions. Here's an overview of the state's educational profile:

Literacy Rate:

As per the 2011 Census, Goa's literacy rate stood at 88.70%, with male literacy at 92.65% and female literacy at 84.66% (en.wikipedia.org)

School Education:

- The state follows the 10+2 system, comprising primary, secondary, and higher secondary levels. Schools in Goa are affiliated with various educational boards, including the Goa Board of Secondary & Higher Secondary Education (GBSHSE), the Central Board of Secondary Education (CBSE), and the Council for the Indian School Certificate Examinations (CISCE).

  Goa's educational landscape reflects its dedication to providing quality education and fostering academic excellence across various fields.

Educational Administration of Goa

Goa's educational administration is structured to oversee and manage both school and higher education through dedicated bodies and institutions.

School Education:

Goa Board of Secondary and Higher Secondary Education (GBSHSE): Established on May 27, 1975, under the "Goa, Daman and Diu Secondary and Higher Secondary Education Board Act, 1975," GBSHSE is a statutory body responsible for:

Granting and revoking recognition for secondary and higher secondary schools.

Advising the government on policy matters related to secondary and higher secondary education.

Developing curricula and syllabi for these educational levels.

Preparing and distributing textbooks.

Conducting examinations for Standard X (SSC) and Standard XII (HSC).

Ensuring fair conduct of examinations and addressing related disputes impartially.

The board conducts examinations twice a year, with approximately 38,457 students appearing annually. (en.wikipedia.org)

This structured administration ensures that Goa maintains a comprehensive and organized educational system, catering to the diverse educational needs of its population.

Digital Literacy of Goa

Goa has made significant strides in digital literacy, reflecting its commitment to integrating technology into the daily lives of its residents.

Internet Literacy:

A study analyzing data from the National Family Health Survey (NFHS-5) indicates that approximately 82.9% of males in Goa have used the internet, positioning the state among the highest in male internet literacy in India (SAS Publishers)

Government Initiatives:

The Goa government has been proactive in promoting digital literacy among its youth, fostering innovation, and supporting the growth of a vibrant startup ecosystem (linkedin.com)

At the national level, schemes like the National Digital Literacy Mission (NDLM) and the Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) have been instrumental in enhancing digital skills across India, including Goa (pib.gov.in)

Overall Literacy Context:

Goa's literacy rate has seen a substantial increase, rising from 88.70% as per the 2011 census to 93.2% according to the National Family Health Survey (2019-21) (gomantaktimes.com)

These developments underscore Goa's dedication to advancing digital literacy, ensuring its citizens are well-equipped to navigate the digital landscape.

Digital Inclusion of Goa

Goa has implemented several initiatives to enhance digital inclusion, focusing on infrastructure development, public service delivery, and community engagement.

Goa Broadband Network (GBBN):

Launched in August 2009, the Goa Broadband Network (GBBN) is a state-wide area network connecting all 12 talukas, 189 village panchayats, 225 office buildings, approximately 1,200 government offices, and over 500 educational institutions through a robust fiber network. This

initiative positions Goa as the first state in India to have an end-to-end IP-based architecture supporting voice, video, and data services. The GBBN facilitates communication among government departments (G2G), businesses (G2B), and citizens (G2C), and supports applications like e-learning, thereby promoting digital inclusion across the state (en.wikipedia.org)

Common Service Centres (CSCs):

As part of the national Digital India initiative, Common Service Centres (CSCs) operate in Goa to provide digital access points for various government and non-government services, particularly in rural and remote areas. Managed by Village Level Entrepreneurs (VLEs), these centres offer services including e-Governance, financial, educational, and healthcare services, thereby promoting digital inclusion and fostering economic development through local entrepreneurship (en.wikipedia.org)

Digital Initiatives by Local Leaders:

Local leaders in Goa have also contributed to digital inclusion efforts. For example, Rohan Khaunte, serving as the Minister for Tourism, IT, E&C, and Printing and Stationery, has been involved in initiatives aimed at integrating technology to simplify common services for citizens. His efforts include launching government websites and promoting digital literacy to ensure that residents can easily access various services online (en.wikipedia.org)

Through these initiatives, Goa continues to make significant strides in promoting digital inclusion, ensuring that its citizens have access to essential digital services and opportunities.

2.2.3 GUJARAT

Educational Profile of Gujarat

Gujarat has made notable advancements in its educational sector, reflecting a commitment to improving literacy and expanding educational infrastructure. Here's an overview of the state's educational profile:

Literacy Rate:

As per the 2011 Census, Gujarat's literacy rate was 78.03%, with male literacy at 85.75% and female literacy at 69.68%.

School Education:

The state has a robust network of schools, encompassing primary, secondary, and higher secondary levels, catering to both urban and rural populations.

Educational Initiatives:

The state government has implemented programs like "Shala Praveshotsav" and "Kanya Kelavani" to boost school enrollment and promote girls' education.

Recent Developments:

Gujarat continues to invest in educational infrastructure, teacher training, and digital learning to enhance the quality of education.

These efforts underscore Gujarat's dedication to fostering an educated and skilled populace, contributing to its socio-economic development.

Educational Administration Of Gujarat

The educational administration of Gujarat is structured to oversee and manage both school and higher education within the state. The system comprises various bodies and institutions responsible for policy formulation, regulation, and implementation.

School Education:

Gujarat Secondary and Higher Secondary Education Board (GSHSEB): Established in 1972 under 'The Gujarat Secondary Education Act 1972', GSHSEB is a governmental body responsible for determining the policy-related, administrative, cognitive, and intellectual direction of the state's secondary and higher secondary educational system. Its key functions include:

Preparing curricula and syllabi.

Registering and administering secondary and higher secondary schools.

Conducting examinations for Secondary School Certificate (SSC) and Higher Secondary (School) Certificate (HSC).

Recognizing new schools and monitoring their performance.

The board also provides guidance to the state government on policies governing secondary education, aiming for its development and qualitative enhancement (en.wikipedia.org)

Digital Literacy of Gujarat

Digital literacy in Gujarat presents a complex picture, influenced by factors such as gender disparities, digital payment awareness, and educational initiatives.

Gender Disparities:

Internet Usage: Only 30.8% of women in Gujarat have used the internet, indicating a significant gender gap in digital access (Economic Times)

Computer Skills: The skill gap between men and women in handling computer files is pronounced, with 62.2% of men and only 38.6% of women reporting proficiency (livemint.com)

Digital Payments Awareness:

Approximately 75.7% of consumers in Gujarat are aware of digital payments, slightly lower than the national average of 77.2% (timesofindia.indiatimes.com)

Educational Initiatives:

Studies indicate that students in Gujarat, particularly those aged 14 to 16, have shown commendable digital literacy levels (ahmedabadmirror.com)

These insights highlight Gujarat's efforts to improve digital literacy while emphasizing the need to address existing disparities to ensure equitable digital access and proficiency across all demographics.

Digital Inclusion of Gujrat

Gujarat has undertaken several initiatives to enhance digital inclusion across the state, focusing on policy frameworks, technological advancements, and community-based projects.

Gujarat IT/ITeS Policy 2022–2027:

Launched in February 2022, this policy aims to strengthen Gujarat's information technology ecosystem. Key objectives include generating 100,000 direct jobs in the IT and IT-enabled Services (ITeS) sector and increasing IT exports from ₹3,101 crore to ₹25,000 crore. The policy emphasizes the creation of world-class co-working spaces, establishment of an Artificial Intelligence (AI) School or Center of Excellence, and offers capital expenditure (CAPEX) support of up to ₹200 crore for mega projects. Additionally, it provides operational expenditure (OPEX) support and incentives for employment generation, including reimbursement of employers' Employees' Provident Fund (EPF) contributions (en.wikipedia.org)

Bhashini Project:

Introduced in August 2022, Bhashini is an Indian government project developed by the Ministry of Electronics and Information Technology under the National Language Translation Mission. It aims to help citizens translate content into various Indian languages, reducing language barriers and promoting digital empowerment. The platform utilizes natural language processing and AI to ensure digital inclusion across different states, including Gujarat (en.wikipedia.org)

Akodara – India's First Digital Village:

Akodara, a village in the Sabarkantha district of Gujarat, has been transformed into India's first digital cashless village. In 2015, the ICICI Foundation adopted and developed Akodara as a digitized village, implementing digital payment systems that enable residents to conduct transactions ranging from ₹10 to ₹5,000 using digital methods. This initiative has significantly enhanced financial inclusion and digital literacy among villagers (en.wikipedia.org)

e-Dhara Kendra:

The e-Dhara project modernizes land administration in Gujarat, enabling farmers to manage land records digitally. Each e-Dhara Kendra, located at Taluka Mamlatdar Offices, provides access to land records, ownership documents, and related services. This digital initiative streamlines land record management, reducing manual interventions and enhancing transparency (en.wikipedia.org) Through these comprehensive efforts, Gujarat continues to promote digital inclusion, aiming to bridge the digital divide and empower its citizens with accessible technological resources.

2.2.4 MADHYA PRADESH

Educational Profile of Madhya Pradesh

Madhya Pradesh has made significant strides in education over the years, reflecting its commitment to improving literacy and educational infrastructure. Here's an overview of the state's educational profile:

Literacy Rate:

According to the 2011 Census, Madhya Pradesh had a literacy rate of 69.32% (en.wikipedia.org)

School Education:

As per 2009–10 data, the state had:

105,592 primary schools

6,352 high schools

5,161 higher secondary schools

The Gross Enrollment Ratio (GER) for classes I-VIII (ages 6–13) in 2011 was 122.6%, indicating a high level of school enrollment (en.wikipedia.org)

Recent Developments:

The state has experienced notable economic growth, with a GDP development ranking of 225% in recent years. This growth has been accompanied by increased emphasis on education, including the appointment of more teachers and the establishment of software parks (en.wikipedia.org)

These developments underscore Madhya Pradesh's ongoing efforts to enhance its educational landscape and provide quality learning opportunities for its residents.

Educational Administration Of Madhya Pradesh

The educational administration of Madhya Pradesh is organized to oversee and manage both school and higher education within the state. The system comprises various bodies and institutions responsible for policy formulation, regulation, and implementation.

School Education:

Madhya Pradesh Board of Secondary Education (MPBSE): Established under The Madhya Pradesh Secondary Education Act of 1965, MPBSE is a governmental body responsible for determining the policy-related, administrative, cognitive, and intellectual direction of the state's higher educational system. Its key functions include:

Granting affiliations to schools.

Prescribing courses and textbooks for high school and intermediate levels.

Conducting examinations for secondary and higher secondary education.

Providing equivalence to examinations conducted by other boards.

MPBSE also provides direction, support, and leadership for all educational institutions under its jurisdiction.

Digital Literacy Of Madhya Pradesh

Digital literacy in Madhya Pradesh presents a multifaceted landscape, influenced by factors such as urban-rural divides, gender disparities, and infrastructural challenges.

Urban-Rural Disparities:

Access to Computers: Only 5.6% of households in Madhya Pradesh have a computer, highlighting limited access to digital devices (timesofindia.indiatimes.com)

Digital Literacy Levels: A study comparing digital literacy among higher education students in rural and urban areas of Madhya Pradesh revealed significant differences. Urban students scored an average of 42.16 in digital literacy assessments, while their rural counterparts scored 30.71 (publications.anveshanaindia.com)

Gender Disparities:

The same study indicated that male students had higher digital literacy levels, with an average score of 39.75, compared to female students, who averaged 34.19 (publications.anveshanaindia.com)

Government Initiatives:

Under the Digital Literacy Mission, Madhya Pradesh has enrolled 785,799 individuals, with 573,416 trained and 287,629 certified, reflecting ongoing efforts to enhance digital skills across the state (pib.gov.in)

Challenges in Rural Education:

Despite a preference for private schools among rural parents, digital literacy remains a concern. High dropout rates, particularly among girls aged 15-16, persist in states like Madhya Pradesh, where the rate stands at 16.1% (indiatoday.in)

Financial and Digital Literacy:

In urban areas, financial literacy is at 33%, while rural areas lag at 24%. Among specific groups, students have a 26% literacy rate, and agricultural laborers are at 13%, indicating a need for targeted digital literacy programs (NABARD)

These insights underscore the necessity for continued efforts to bridge digital literacy gaps in Madhya Pradesh, focusing on equitable access to technology and education across all demographics.

Digital Inclusion Of Madhya Pradesh

Madhya Pradesh has undertaken several initiatives to enhance digital inclusion, aiming to bridge the digital divide and empower its residents with digital skills and access.

All India Society for Electronics and Computer Technology (AISECT):

Established in 1985 in Bhopal, AISECT is a social enterprise focused on extending computer education to rural and semi-urban populations. Operating across 28 states and four union territories, AISECT manages over 23,000 service delivery centers, providing skill development, training, higher education, and e-governance services (en.wikipedia.org)

E-Choupal Initiative:

Launched by ITC Limited, the e-Choupal initiative connects directly with rural farmers via the internet, facilitating the procurement of agricultural products like soybeans and wheat. This program installs computers with internet access in villages, offering farmers up-to-date market and agricultural information, thereby improving their income levels and reducing transaction costs. As of now, there are 6,100 e-Choupals in operation across 35,000 villages in 10 states, including Madhya Pradesh, benefiting around 4 million farmers (en.wikipedia.org)

Nand Ghar Project:

The Nand Ghar initiative, present in 14 states including Madhya Pradesh, aims to modernize Anganwadis (rural child care centers) by providing resources for education, nutrition, and healthcare. During the COVID-19 pandemic, Nand Ghar launched telemedicine services and e-learning content, reaching over 55,000 children in rural areas. This project also converted multiple centers into vaccination sites and COVID care facilities, supporting community health and digital education efforts (en.wikipedia.org)

Pradhan Mantri SVANidhi Scheme:

Launched on June 1, 2020, this micro-credit scheme aims to empower street vendors affected by the COVID-19 pandemic by providing affordable working capital loans. The scheme promotes digital transactions among street vendors by offering cash-back incentives for using digital payment methods, thereby encouraging digital inclusion within this segment (en.wikipedia.org)

These initiatives collectively contribute to enhancing digital inclusion in Madhya Pradesh, focusing on education, agriculture, healthcare, and financial services to empower its residents with essential digital skills and access.

2.2.5 MAHARASHTRA

Educational Profile of Maharashtra

Maharashtra has made significant advancements in education, reflecting its commitment to improving literacy and expanding educational infrastructure. Here's an overview of the state's educational profile:

Literacy Rate:

According to the 2018 report on 'Household Social Consumption: Education in India' by the National Sample Survey, Maharashtra's literacy rate was 84.8%, positioning it among the top-performing states in India (en.wikipedia.org)

School Education:

The state follows the 10+2 system of school education, comprising primary, secondary, and higher secondary levels. A diverse range of schools operate under various boards, including the Maharashtra State Board of Secondary and Higher Secondary Education (MSBSHSE), Central Board of Secondary Education (CBSE), and Council for the Indian School Certificate Examinations (CISCE).

The contribution is significantly increased to Maharashtra's educational landscape, fostering a skilled workforce and promoting research and innovation across various fields.

Educational Administration of Maharashtra

Maharashtra's educational administration is structured to oversee and manage both school and higher education through dedicated ministries and regulatory bodies.

School Education:

Ministry of School Education: This ministry is responsible for formulating and implementing policies related to school education in Maharashtra. It oversees various departments and institutions to ensure the effective delivery of primary and secondary education across the state (en.wikipedia.org)

Maharashtra State Board of Secondary and Higher Secondary Education (MSBSHSE):

Established on January 1, 1966, under the "Maharashtra Secondary Boards Act" of 1965, MSBSHSE is a statutory and autonomous body. Its primary responsibilities include:

Formulating and implementing rules and regulations in accordance with state and central guidelines.

Developing curricula and syllabi for secondary and higher secondary education.

Preparing and distributing textbooks.

Conducting examinations for the Secondary School Certificate (SSC) and Higher Secondary Certificate (HSC).

Ensuring fair conduct of examinations and addressing disputes impartially.

The board conducts examinations twice a year, with approximately 1.4 million students appearing for HSC and 1.7 million for SSC annually (en.wikipedia.org)

This structured approach ensures that Maharashtra maintains a comprehensive and organized educational system, catering to the diverse educational needs of its population

Digital Literacy of Maharashtra

Digital literacy in Maharashtra reflects a blend of progress and ongoing challenges, influenced by factors such as gender, urban-rural divides, and targeted government initiatives.

Overall Digital Literacy:

Approximately 54.3% of individuals in Maharashtra possess computer literacy skills, indicating a moderate level of digital proficiency within the state (livemint.com)

Gender Disparities:

Internet usage among women in Maharashtra stands at 38%, highlighting a significant gender gap in digital access and literacy (Economic Times)

Urban-Rural Divide:

Nationally, urban areas exhibit a digital literacy rate of 61%, while rural areas lag behind at 25%. Although specific urban-rural statistics for Maharashtra are not provided, it is reasonable to infer a similar trend within the state (bwpeople.in)

Government Initiatives:

Under the Digital Literacy Mission, Maharashtra has made strides in enhancing digital skills, with 811,791 individuals trained, 614,597 of whom have been certified, and 330,928 actively utilizing their digital literacy skills (pib.gov.in)

These insights underscore Maharashtra's efforts to improve digital literacy while highlighting areas requiring continued attention to bridge existing gaps.

Digital Inclusion of Maharashtra

Maharashtra has implemented several initiatives to promote digital inclusion across the state, focusing on education, rural development, and technological empowerment.

Maharashtra Knowledge Corporation Limited (MKCL):

Established in 2001, MKCL is a public limited company promoted by the Department of Higher and Technical Education, Government of Maharashtra. It aims to bridge the digital divide by offering IT literacy courses, notably the Maharashtra State Certificate in Information Technology (MS-CIT), which has enrolled over 1.5 crore learners. MKCL operates through a network of over 5,000 Authorized Learning Centers across Maharashtra, providing eLearning modules, hands-on practice, and certified guidance (en.wikipedia.org)

SmartGaon Development Foundation:

Founded in 2017, the SmartGaon Development Foundation focuses on digitizing and developing rural infrastructure in India. One of its notable projects includes transforming the village of Chinchani in Palghar district into a "SmartGaon" by implementing digital infrastructure, smart farming practices, and mobile app facilities to connect the village globally. The SmartGaon app allows villagers to access information related to government schemes, monitor development initiatives, and engage in an online marketplace to buy and sell farm produce, supporting fair trade for farmers (en.wikipedia.org)

eVidyaloka:

eVidyaloka is a Bangalore-based NGO that imparts education to students in rural government schools by connecting volunteer teachers through digital platforms. In Maharashtra, eVidyaloka focuses on teaching English, Math, and Science to high school students, utilizing video conferencing tools like Skype and Webex. This initiative addresses the shortage of qualified teachers in remote areas, enhancing the quality of education and digital literacy among rural students (en.wikipedia.org)

These initiatives collectively contribute to enhancing digital inclusion in Maharashtra, empowering residents with essential digital skills and access to technology.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

'Technology can become the "wings" that will allow the educational world to fly farther and faster' **- Jenny Arledge**

The modern era is known as a scientific and technological era,wedirectly pushed the education system from traditional to digitalization, in this endeavor, Atal Tinkering Labs became a game changer for promoting and enhancing creativity, constructively, and critical thinking among the students. Therefore, in this scientific juncture, it's of utmost importance to develop an inclusive technology-friendly education ecosystem that caters to the changes and challenges of 21st-century learners. Science and technology make life easier and more comfortable for humans. Science and technology enable us to save time, effort, and money. Science and technology open the door to new perspectives of understanding,and science and technology aid in the advancement of the field of education. Science and Technology are important aspects of this globalized life. Most importantly, it helps us to save time, which is one of the results of advancements in science and technology. These include improved communication between students and teachers, personalized learning opportunities, and expanded access to Primary Education to higher education, and increased student engagement and motivation ***(Kaur, 2019; Sharma, 2021; Collaco,2017).*** Technology has made classroom collaboration more efficient, broadening students' academic and intellectual horizons. Science encompasses the systematic study of the structure and behavior of the physical and natural world through observation and experiment, and technology is the application of scientific knowledge for practical purposes ***(Dorf, 2001; Kierk,2000).***

3.2 RESEARCH TRENDS OF EDUCATIONAL TECHNOLOGY: A METHODOLOGICAL SHIFT

Research is an attempt to gain new knowledge about a problem. Through the proper methodology, the Researcher seeks to fulfill the objectives and gain new knowledge. It is a structured process and procedure used to explore the research problems successfully. It is a method thathelps in the study of research method that helps in the study of research methods. It is a structured method used to achieve specific goals, and if we use this method in terms of research, then we find new knowledge. The method involves various steps such as selecting a sample, collecting data from this sample, and lastly interpreting the data. These steps involvedetailed explanation and

analysisfor the proper findings and justifications. It helps the researcher to understand that the research method they used in the study is successful. Based on the objectives of the research, its advantages can also be described and various comparisons can be discussed.

A research method is a method in which all explanations are available on how the researcher will carry out or conduct the said research activity. If the researcher wants to research a subject, first he has to select the problem, and it is a logical and systematic plan to solve the research problem. It helps the researcher to get the details of his research. Hence, the Researcher selected this problem to study the effectiveness of Atal Tinkering Labs for promoting the creativity, creative thinking, and entrepreneurial skills among the secondary students.

To design a research method, the researcher has to face various problems and make the right decision and execute the method scientifically. The most important thing here is what kind of data collection method the researcher used for fulfillment of the objectives. In this study, the researcher collected both Quantitative and Qualitative data,and the researcher adopted a mixed method approach.

This method helps the researcher to concludethe research work with juxtaposing the qualitative and quantitative data, the researcher explored the effectiveness of Atal Tinkering Labs, and the researcher also explored the effectiveness of Atal Tinkering Labs to know the effectiveness of ATL for enhancement of digital capability among the learners. It makes the research process efficient and manageable. When researcher receives criticism about the study, they can cite the methodology and explain the methodology.

The researcher has tried to perform the task using the methodology type in this study,which is quantitative methods. Quantitative methods are used only when the objective of the research is to ascertain something. It focuses on collecting, testing, and measuring data from a large sample size. After collecting the data, the researcher analyzes it using statistical analysis and comparison. The methods used to collect this quantitative data are questionnaire, examination, organizational records, surveys, etc.

By nature, this study was a mixed-method research design to juxtapose the quality and quantitative attributes. Based on the stated objectives, collected data, and fulfillment of the objectives. According to the objectives, the researcher collected quantitative and qualitative data and fulfilled of the objectives.Through the student's feedback form, the researcher assessed use of the Atal program, and the researcher also developed a questionnaire for assessing the ATL In-charge feedback and uses of ATL in schools, besides these tools, the researcher administered the Schedule, the achievement test, and the attitude scale, based on the purpose of the study. The

researcher has known the students' attitude towards Entrepreneurship skills through a self-made 5-pointLikert-type attitude scale.

3.3 AREA OF THE STUDY

The study areas of the present study are confined tothe Western Region of Madhya Pradesh, Chhattisgarh, Maharashtra, Goa, and Gujarat State.

3.4 POPULATION OF THE STUDY

Inthe western region of Madhya Pradesh, Chhattisgarh, Maharashtra, Goa, and Gujarat State there are 2078 schools in which Atal Tinkering Labs are functioning properly. From the western region, the researcher selected five states and 23 schools having Atal Tinkering Labs.

3.5 SAMPLE AND SAMPLING TECHNIQUE OF THE STUDY

From the entire population, the researcher selected 23 schools as a sample, and from the selected schools, the researcher selected 22 ATL-in-Charge and 618 Students as a sample through Random Sampling Techniques, and later the Researcher classified the sample through Stratified sampling. Strata were based on Male, Female, Urban, Rural, and Semester wise, Govt and Private, etc.

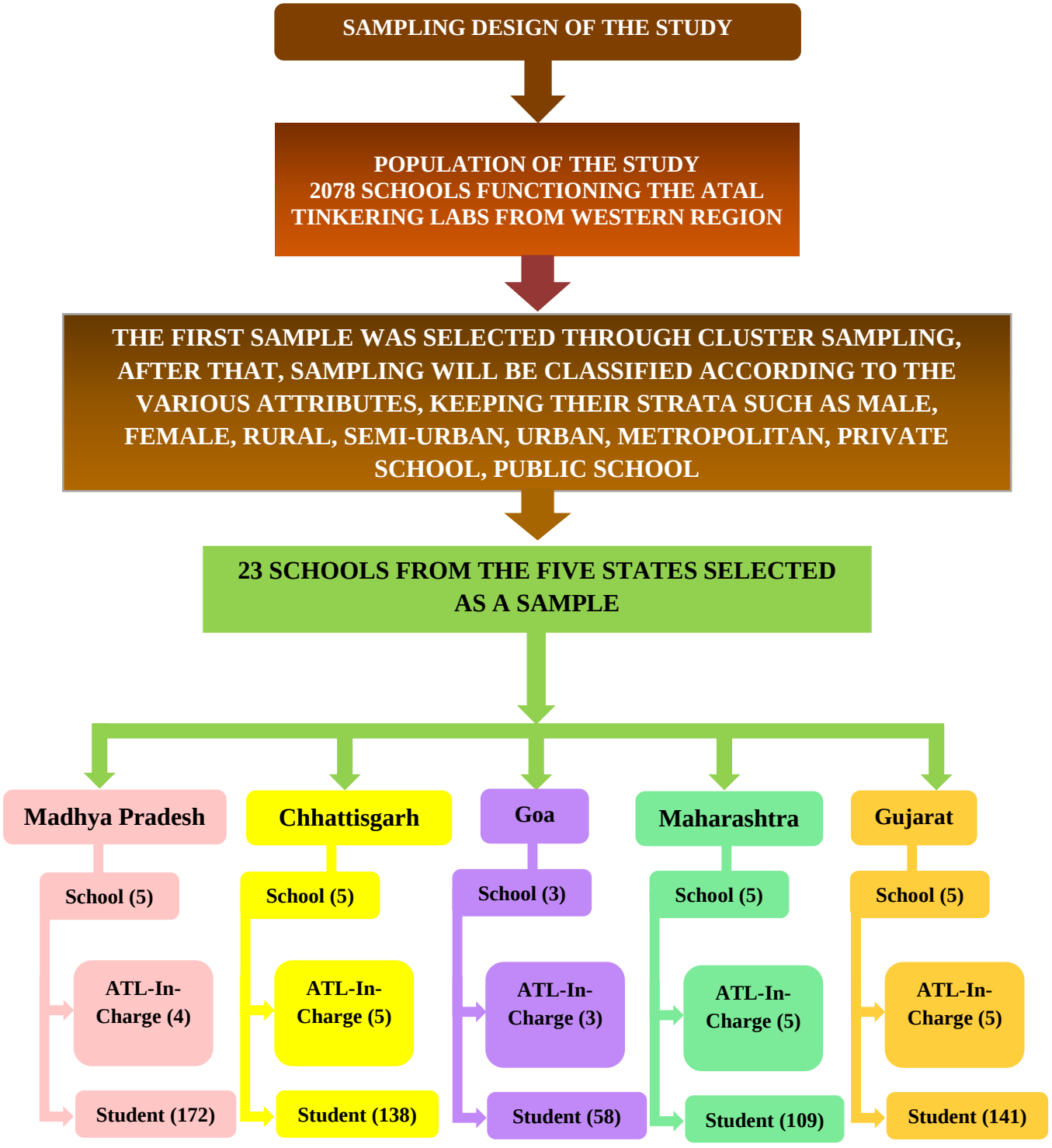


Figure3.1: Sampling Diagram

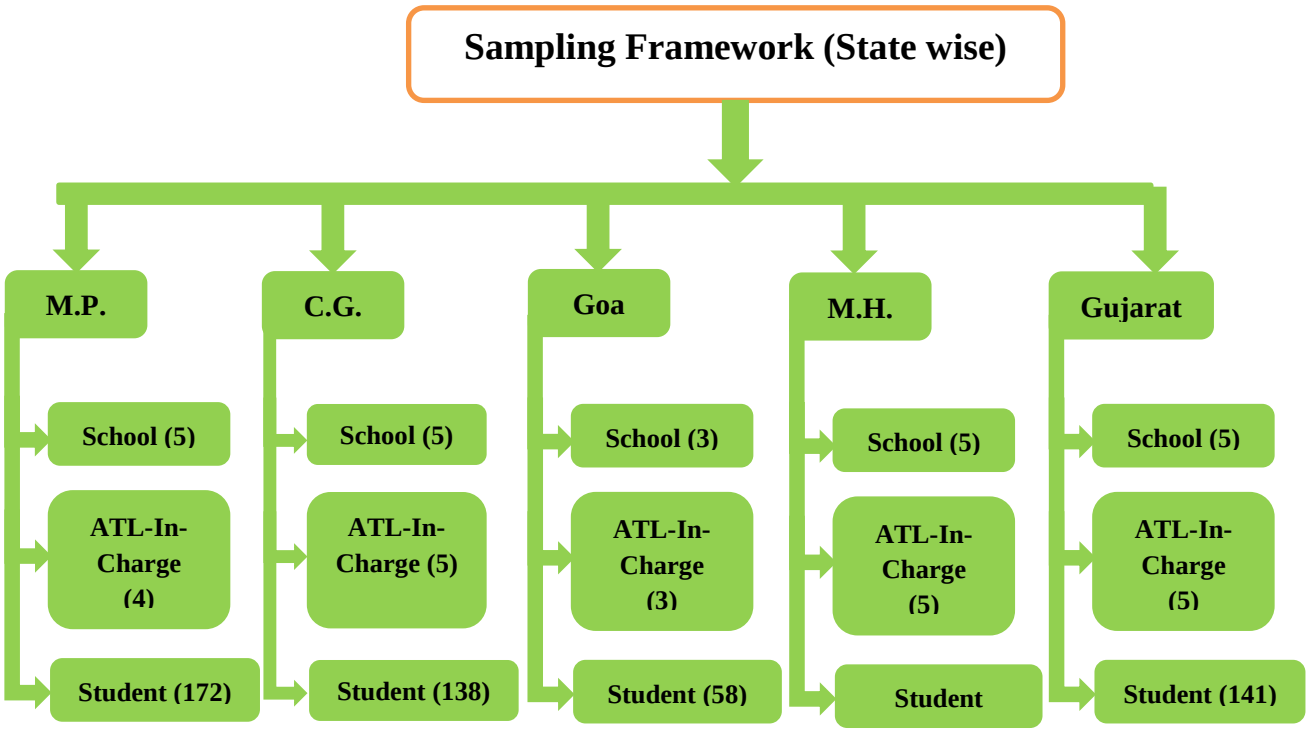


Figure 3.2: Sampling Framework based on State

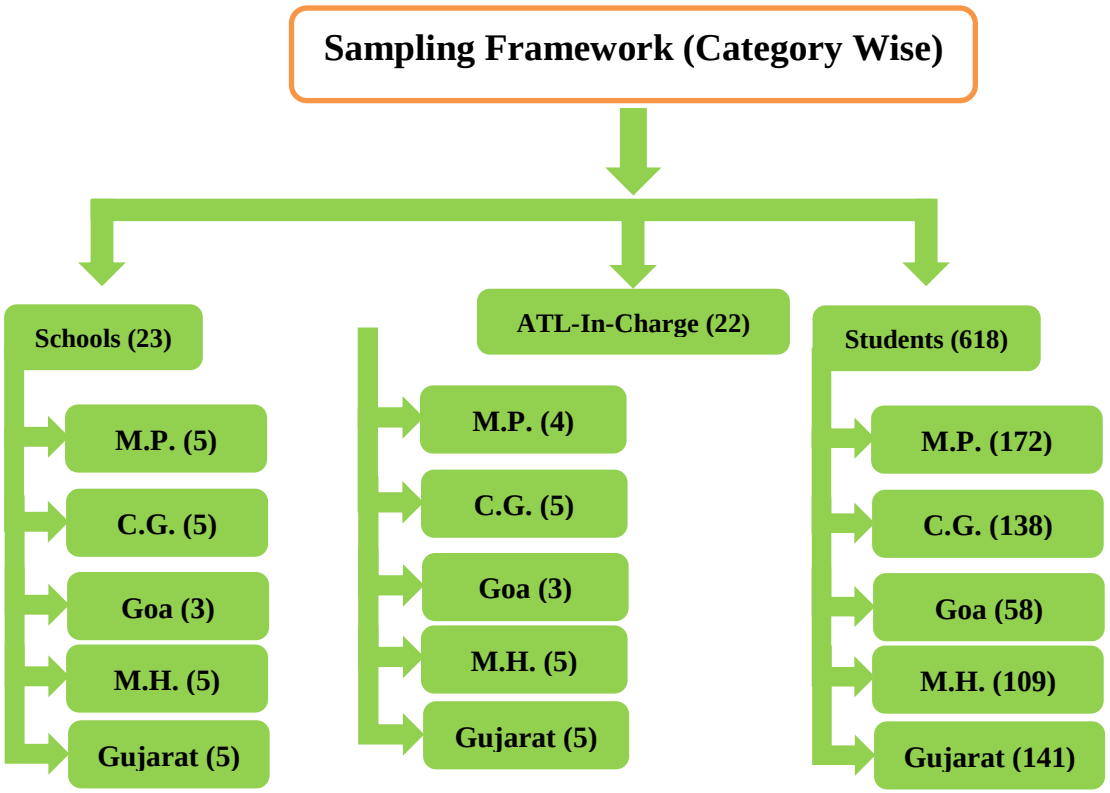


Figure 3.3: Sampling Framework Based on Categories

Hence, figure 3.3reflected that the twenty-three Secondary Schools implementing ATL scheme were selected as a sample following stratified sampling technique (Sample classified into various strata). The number of schools was selected from each state of the western region based on the size of the population of the respective State. From these 23 schools, two schools were chosen for the case study.

3.6 TOOLS USED IN THE STUDY

The researchercollected the data through a self-made five-point Likert-type attitude scale, and besides the attitude scale, the researcher also collected data from the Govt report, books, journal, article, research paper, newspaper, etc.

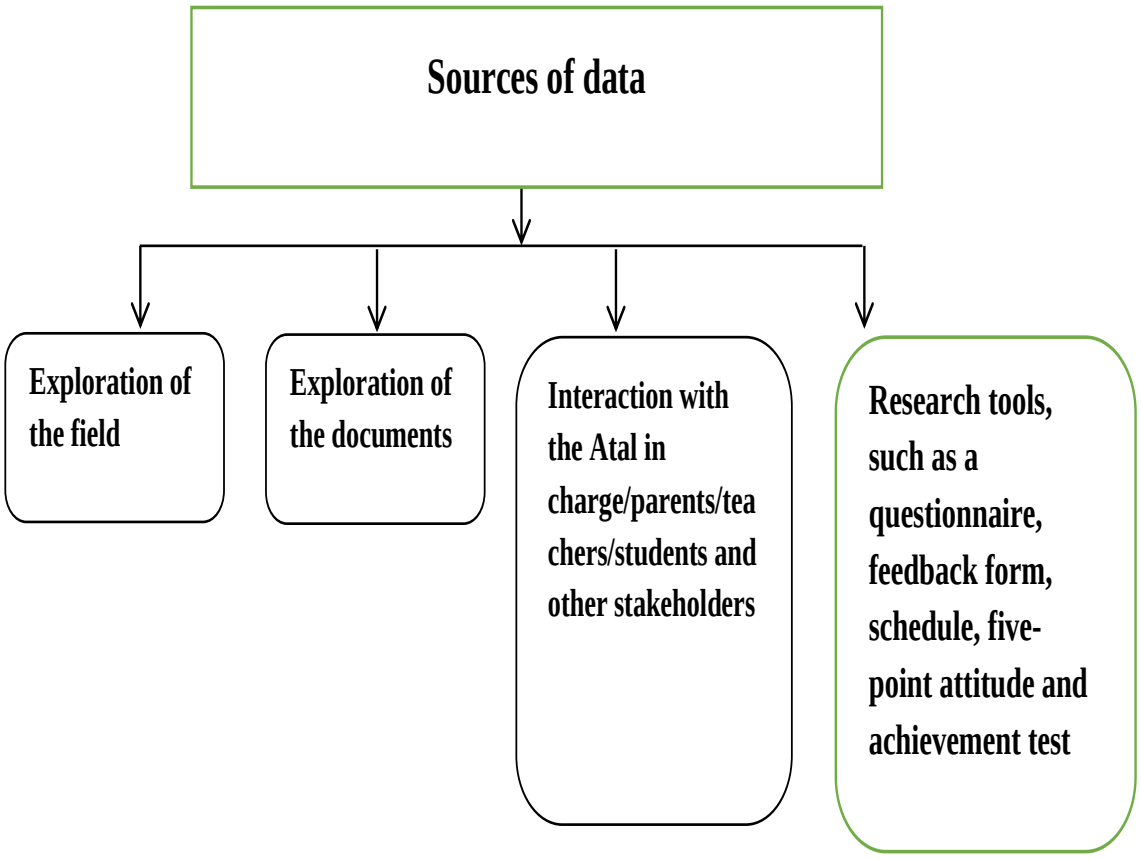


Figure 3.4: Source of the Data

3.7 STATISTICAL TREATMENT

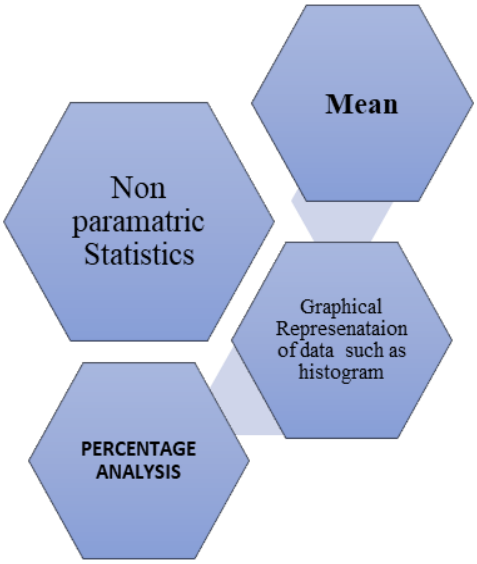


Figure 3.5: Statistical Treatments

3.8 ANALYSIS OF DATA

Data analysis plays a crucial role in research across various fields, including social sciences, natural sciences, engineering, and other disciplines. It involves inspecting, cleaning, transforming, and modeling data to extract meaningful insights, draw conclusions, and support evidence-based decision-making.

Data analysis in MMR (Mix-Method Research) involves interpreting and analyzingfirst-hand resources and also second-hand sources, such as primary documents, diaries, newspapers, photographs, writings, and other archival materials.

3.8.1 FAMILIARIZATION WITH THE DATA

Researchers begin by immersing themselves in the historical background of the study and data to gain a deep understanding of the context, themes, and content. This involves reading and re-

reading primary sources, such as diaries, letters (***govt gazette notification)***, newspapers, and archival documents, and conducting literature reviews to grasp the historical background.

3.8.2 THEME DEVELOPMENT

Researchers identify common patterns, themes and concepts emerging from the data as coding progresses. These themes capture important aspects or recurring ideas within the historical context. Themes are developed by grouping related codes and exploring connections and relationships between different elements in the data, such as creative thinking, constructive thinking, and entrepreneurial skills.

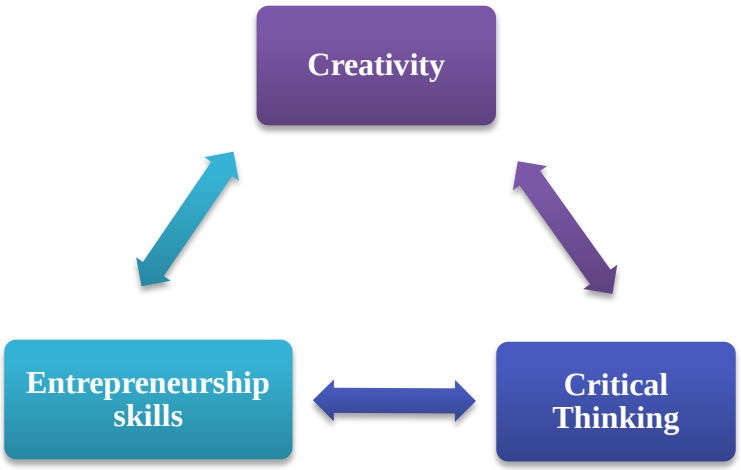


Figure 3.6: Triangulation

3.8.3 INTERPRETATION AND ANALYSIS

Researchers interpret historical data to make sense of it. This involves critically analyzing the coded data and the identified themes, considering the historical context, and interpreting the significance of the findings. Researchers may draw upon existing theories or develop new theoretical frameworks to guide their analysis.

3.8.4 TRIANGULATION

Qualitative analysis demands the triangulation to enhance the credibility and reliability of findings. Triangulation involves using multiple sources of evidence, such as different types of

primary sources, secondary sources, and different perspectives, to corroborate and validate interpretations.

3.8.5 CONTEXTUALIZATION

In Mix-Method research, it is crucial to provide rich contextual information to support the analysis and interpretation. This involves situating the findings within the stipulated period, considering Educational, Social, Political, Economic, and Cultural factors, and understanding the broader significance of the research.

In this research, the researcher collected primary and secondary data using various tools and techniques. Different data analysis procedures and techniques were used to extract the meaning of the data.

In the present study, content analysis, thematic analysis and hermeneutics were used for data analysis.

3.8.6 CONTENT CUM CONTEXT ANALYSIS

To know the uses of ATL in secondary educational of western regions of India researcher collected data from various means and analysis with context cum content analysis.

3.8.7 THEMATIC ANALYSIS

Through it, the researcher explored the present status of Atal tinkering labs and its essence for promoting the 21st century skills among the secondary students.
Here, the researcher developed some themes such as technology, innovation, construction, creation, and entrepreneurship skills.

3.8.8 HERMENEUTICS ANALYSIS

The objectives are also fulfilled through hermeneutics analysis by juxtaposing two or more phenomenainterpretatively, such as function and application of ATL and students' academic achievement and Atal Tinkering Labs and effectiveness of Atal Tinkering Labs for enhancing students learning outcomes which means how far Atal Tinkering Labs foster towards the creativity and constructability among the secondary schools' students for promoting the creativity and constructability.

3.8.9 DOCUMENT ANALYSIS

A qualitative research technique known as ‘document analysis’ entails the in-depth examination of written materials to shed light on the investigated subject. Documents can be of any kind, including books, articles, reports, letters, emails, and even social media posts. The objectives of document analysis are to understand the document's meaning, setting, and relevance to the research issue. In this research, the Researcher analyzeddifferent students' examination copies for assessing their academic achievement, and the researcher also did coding with the creativity inventory and other tools for data collection.

3.9 OVERVIEW OF THE METHODOLOGY

3.9.1 RESEARCH DESIGN

The study adopted a mixed-methods research design (combination of both quantitative and qualitative data), viz. Embedded Design, for carrying out the study. Descriptive research method was employed in the quantitative aspect and case study research method was employed in the qualitative aspect of the study. Both quantitative and qualitative data were gathered simultaneously, with the purpose being to support the findings of the other design.

3.9.2 TOOLS AND TECHNIQUES

The following tools and techniques, designed by the investigator, were used for the collection of data:

i. **Documentary Analysis:** Analysis of the records pertaining, inter alia, to the list of equipment available, daily attendance of students who use the lab, and daily attendance of teachers and/or attendant support students, etc. to know the functioning of ATL.
ii. **Interview Schedules:** Separate Schedules for the school heads and teachers associated with ATL were used to enquire about their perception on Strengths, Weaknesses, Opportunities and Challenges (SWOC) in the implementation of ATL

iii. **Focus Group Discussion (FGD):** Focus Group Discussion guidelines for students were used to enquire about their perception on different aspects of implementing the scheme e.g., availability of equipment, support of teachers, age appropriateness of equipment, quality of equipment, learning time, etc.

iv. **Check-list**: A checklist was used to gather information pertaining to quality and usability of the available infrastructure and learning resources/equipment as per the guideline.

v. **Lab Observation Schedule:** The schedule was used to see the overall functioning of the laboratory, mainly with reference to the quality of space and infrastructure, use of labs by the students, support mechanism, lab time table, etc.

3.9.3 DATA COLLECTION AND PROCESSING

Data was collected from the key informants such as head teachers, teachers and students, by field investigators. And was processed manually by the same investigators (s) but under the supervision of the investigator.

3.9.4 DATA ANALYSIS

The data collected through the structured tools such as Interview Schedule for the school heads and teachers, check-list to know the availability of infrastructure and learning resources, and Lab Observation Schedule, was analysed with the help of the quantitative technique of percentage. The data collected through the unstructured/semi-structured tools, such as Documentary Analysis to know the functioning of ATL, and Focus Group Discussions guidelines for students, was analysed with the help of the qualitative technique of Thick Description.

3.9.5 FOLLOW-UP MECHANISM

The following steps will be taken to follow-up the performance/activities of the students of class XII included in the sample, which are passed out of the school:

i. A list of the students with their address for communication was prepared.

ii. The interest of such students at the time of exit was assessed with the help of an interest inventory.

iii. Periodic data regarding their choice of courses/profession requiring 21st Century skills and progression/interest therein was collected through online form.

OBJECTIVES	DATA COLLECTION FROM WHOM	TOOLS FOR DATA COLLECTION	NATURE OF DATA	STATISTICAL TREATMENT
To study the status of the use of ATL in Secondary Schools of the Western Region in India, i.e., the study area.	Students and teachers & visit the schools implementing ATL	Closed-ended questionnaire checklist/information schedule	Both Qualitative & Quantitative	Graphical Representation, Pie, Histogram
To study the effectiveness of ATL in the achievement of Learning Outcomes of Secondary School students of the study area.	Students who benefit from at least receiving at least a 2-year education through ATL	Achievement Test for students	Quantitative	Mean, percentage, and graphical percentage
To study the effectiveness of ATL in promoting key 21st-century skills, viz. Creativity, Innovation, Entrepreneurship, Critical thinking, and Design thinking among Secondary School students of the study area.	Students, Students who benefit from at least receiving a 2-year education through ATL	Achievement Test for students	Quantitative	Correlation of cooperation, rank differently, product moment, and any other correction
To explore the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) associated with the implementation of ATL in Secondary Schools of the study area.	Interview with students, Teachers, Administrators, & Parents Lab observation schedule	Strength (student, teachers & parents) weakness –(students-teachers) opportunity- (teachers, administrator) challenges- (teachers, administrator)	Both Qualitative & Quantitative	Graphical Representation, Pie, Histogram
To identify the best practices associated with ATL.	school headmasters & teachers	Observational schedule & semi-structured interview/ case study	Qualitative	
To suggest a framework for better implementation of ATL in Secondary Schools of the study area and to provide inputs to ATL Sarthi Scheme.	Fulfilment of the above objectives & outcome, the researcher may develop a frame and implementation strategies	Observational schedule & semi-structured interview/ case study	Both Qualitative & Quantitative	Figure, table, chart, map

Table 3.1: Methodolgy Table

CHAPTER 4

RESULTS

And

DISCUSSIONS

4.1 RESULTS OF OBJECTIVE-1

Objective 1: To study the status of the use of ATL in Secondary Schools of Western Region in India, i.e. the study area (From Student's perspective)

4.1.1 FUNCTIONING OF ATALS: FROM THE PERSPECTIVE OF STUDENTS

Atal Tinkering Labs (ATL),were started with the aim of fostering innovation, creativity, and problem-solving skills among school students by providing them with access to advanced tools and resources. While ATL has been widely implemented in schools across India, the extent of its utilization in secondary schools of the Western Region (Gujarat, Maharashtra, Chhattisgarh, Goa, and Madhya Pradesh) has been presented in this chapter. In this chapter we have analyzed the data of 618 students and 25 ATL in-charges from different schools.The data was collected using**Tool 1**i.e; To study the status of the use of ATL in Secondary Schools of Western Region in India,given Annexure A.

The status of the use of ATL in Secondary Schools of Western Region in India by studentshave been studied under the following dimensions

1. Frequency of use of ATL

2. Duration of engagement with ATL

3. Support from ATL in-charge

4. Accessibility of ATL facilities beyond school hours

5. Degree of Participation in ATL in-charge

6. Scope of opportunity for peer collaboration

7. Motivational factors to participate in ATL activities

8. Interest in ATL activity

9. Effectiveness of Mentor of change (MOC)

10. Influence of ATL engagement on carrier choices

For the frequency of use of ATL for different states of western region it was found that highest daily usage of ATL was in urban schools of Chhattisgarh state (50%). The overall percentage of daily visit by students of all rural schools is 36.58% and for urban schools it is 18.5%. On comparing the frequency of students visit to the ATL lab it is found that for both rural and urban schools the highest percentage (55.28% for urban and 48.78% for rural) is weekly.

Most of the students are engaged in ATL activities for a period of 1-2 years for all states including both rural and urban schools. Regarding support from ATL in-chargemost of the students get support from ATL in-charge always (58.53%) of all states. Accessibility of ATL facilities beyond school hours is available always in 45.12% schools with M.P rural in the top list (90%). Degree of Participation in ATL in-charge is available always in 45.12% schools with Gujarat rural in top list (100%). Scope of opportunity for peer collaboration is available to about half of the students (50.60%) always. Motivational factors to participate in ATL activities studied were (a) Interest in science and technology- 50% of students reported that they are motivated to take part in ATL activities due to their interest in science and technology. (b) Desire to learn new skills – Around 31.09% participated in ATL activities to learn new skills. (c) Encouragement from teachers – was only 12.80% for participation in ATL activities. (d) Influence of peers was low only 6.09%. Goa is highest in terms of Interest in science and technology 78.05% for urban and 88.24% for rural. For urban areas of Gujarat state 65% students had the desire to learn new skills from participation in ATL activities which was the highest among all states. With regards to encouragement from teachers and influence of peers the percentages are generally low for all states both for urban and rural areas. Most of the students expressed interest in ATL activities from high to very high range (Very high =38.41%, High=35.97%) for all the states. Only few students reported moderate (12.19%) and low interest (13.41%) in ATL activities. Students of Gujarat state reported a very high interest in ATL activities (66.45%) as compared to other states. Effectiveness of Mentor of change (MOC) ranged from excellent (31.09%) to good (36.58%) for all the states. Influence of ATL engagement on carrier choices significantly increased for more than half of the students for all states (59.14%). The overall statistics for different states is presented in Table 4.1 and in figures 4.1 to 4.10.

Aspects of Functioning	Response of secondary school students (%)											
	Chhattisgarh		Gujarat		MP		Maharashtra		Goa		overall	
	U	R	U	R	U	R	U	R	U	R	U	R
1. Use of ATL (1)												
Daily	50	48.0	11.61	10.34	26.32	25.00	10.09	NA	0.00	17.65	18.50	36.58
Weekly	22.5	31.6	55.36	89.66	51.32	70.00	73.39	NA	53.66	52.94	55.28	48.78
Monthly	15	13.3	10.71	0.00	12.50	0.00	3.67	NA	0.00	11.76	9.03	9.14
Rarely	12.5	7.1	22.32	0.00	9.87	5.00	12.84	NA	46.34	17.65	17.18	5.48
2. Duration of engagement with ATL (3)												
1-2 years	50.00	42.86	76.79	86.21	73.68	70.00	58.72	NA	43.90	64.71	66.07	56.09
2- 3 years	22.50	30.61	14.29	13.79	19.74	30.00	33.94	NA	19.51	23.53	22.02	26.82
3-4 years	17.50	21.43	2.68	0.00	4.61	0.00	4.59	NA	14.63	11.76	6.16	14.02
More than 4 years	10.00	5.10	6.25	0.00	1.97	0.00	2.75	NA	21.95	0.00	5.72	3.04
3. Support from ATL in-charge (9)												
Always	52.50	43.86	75.89	96.55	53.29	80.00	76.15	NA	60.98	58.82	64.97	58.53
Often	15.00	30.59	14.29	0.00	30.92	15.00	6.42	NA	36.59	41.18	20.04	25
Rarely	17.50	14.29	7.14	0.00	9.87	5.00	15.60	NA	2.44	0.00	10.57	9.14
Never	15.00	11.26	2.68	3.45	5.92	0.00	1.83	NA	0.00	0.00	4.40	7.31
4. Accessibility of ATL facilities beyond school hours (8)												
Always	60.00	44.90	31.25	10.34	34.87	90.00	46.79	NA	34.15	52.94	38.98	45.12
Occasionally	27.50	34.69	44.64	3.45	46.05	10.00	33.03	NA	31.	35.	39.	26.21

									71	29	64	
Rarely	10.00	14.29	20.54	0.00	15.79	0.00	17.43	NA	26.83	5.88	17.84	9.14
Never	2.50	6.12	3.57	86.21	3.29	0.00	2.75	NA	7.32	5.88	3.52	19.51
5. Degree of Participation in ATL in-charge (6)												
Always	47.50	32.65	42.86	82.76	21.71	35.00	65.14	NA	2.44	64.71	37.88	45.12
Often	25.00	26.53	30.36	10.34	56.58	55.00	14.68	NA	31.71	11.76	35.02	25.60
Seldom	20.00	27.55	17.86	6.90	13.16	10.00	19.27	NA	63.41	17.65	20.92	20.73
Never	7.50	13.27	8.93	0.00	8.55	0.00	0.92	NA	2.44	5.88	6.16	8.53
6. Scope of opportunity for peer collaboration (11)												
Always	42.50	37.76	42.86	100.00	21.71	35.00	59.63	NA	51.22	58.82	40.52	50.60
Often	20.00	26.53	25.89	0.00	42.11	70.00	18.35	NA	7.32	23.53	27.75	25.60
Sometimes	27.50	26.53	27.68	0.00	30.92	5.00	20.18	NA	39.02	17.65	27.97	18.29
Rarely	10.00	9.18	3.57	0.00	5.26	0.00	1.83	NA	2.44	0.00	3.74	5.48
7. Motivational factors to participate in ATL activities (5)												
Interest in science and technology	55.00	40.82	56.25	72.41	57.24	30.00	45.87	NA	78.05	88.24	55.94	50
Desire to learn new skills	20.00	28.57	40.18	27.59	21.05	65.00	48.62	NA	14.63	11.76	31.71	31.09
Encouragement from teachers	22.50	20.41	1.79	0.00	8.55	5.00	3.67	NA	7.32	0.00	6.82	12.80
Influence of peers	2.50	10.20	1.79	0.00	13.16	0.00	1.83	NA	0.00	0.00	5.50	6.09
8. Interest in ATL activity (4)												
Very high	62.50	32.65	36.61	79.31	66.45	5.00	41.28	NA	46.	41.	50.	38.41

									34	18	88	
High	15.00	28.57	41.07	13.79	16.45	85.00	36.70	NA	29.27	58.82	28.41	35.97
Moderate	15.00	16.33	18.75	6.90	14.47	10.00	19.27	NA	21.95	0.00	17.40	12.19
Low	7.50	22.45	3.57	0.00	2.63	0.00	2.75	NA	2.44	0.00	3.30	13.41
9. **Effectiveness of Mentor of change (MOC)** (10)												
Excellent	47.50	41.84	34.82	0.00	17.11	15.00	41.28	NA	17.07	41.18	29.95	31.09
Good	25.00	33.67	58.93	6.90	57.89	75.00	52.29	NA	41.46	58.82	52.42	36.58
Average	22.50	17.35	6.25	0.00	19.08	10.00	6.42	NA	2.44	0.00	11.67	11.58
Poor	5.00	7.14	0.00	93.10	5.92	0.00	0.00	NA	39.02	0.00	5.94	20.73
10. Influence of ATL engagement on carrier choices (12)												
Significant increased	42.50	42.86	49.11	100.00	38.16	85.00	56.88	NA	41.46	52.94	46.03524	59.14
Moderately increased	32.50	36.73	39.29	0.00	36.84	15.00	34.86	NA	46.34	47.06	37.44493	28.65
Slightly increased	17.50	12.24	9.82	0.00	22.37	0.00	7.34	NA	12.20	0.00	14.31	7.31
Insignificant	——	8.16	1.79	0.00	2.63	0.00	0.92	NA	0.00	0.00	2.20	4.87

Table 4.1: Response of secondary school students (%) on various aspects of functioning of ATL for all states (on the basis of locale and overall)

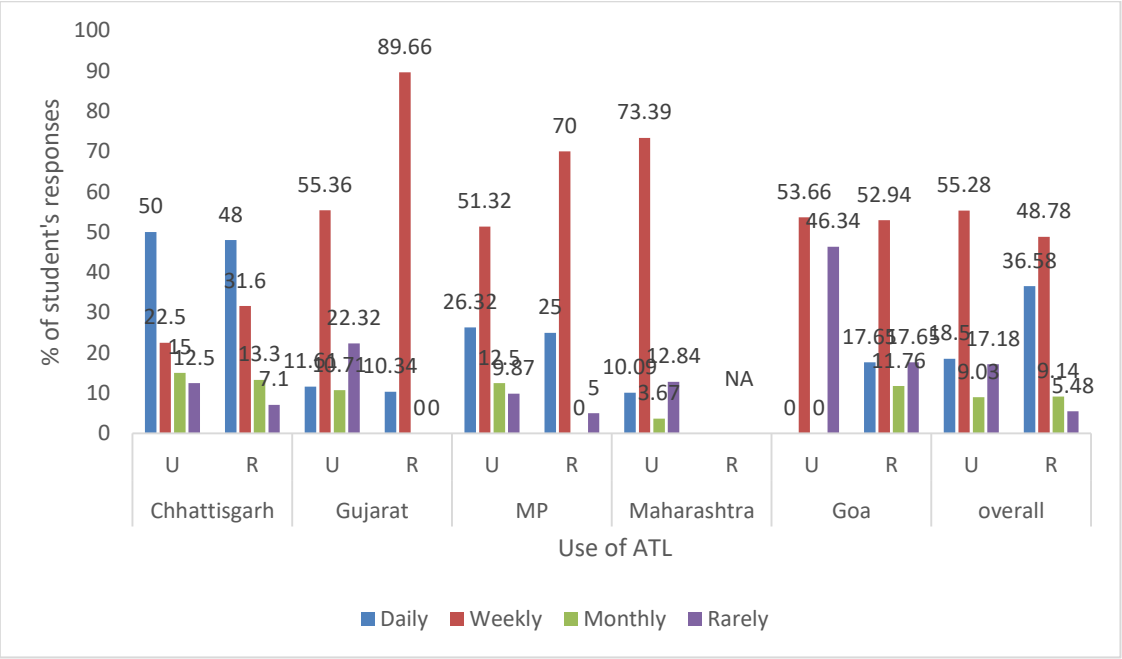


Figure 4.1: State-wise comparison regarding use of ATL on the basis of locality

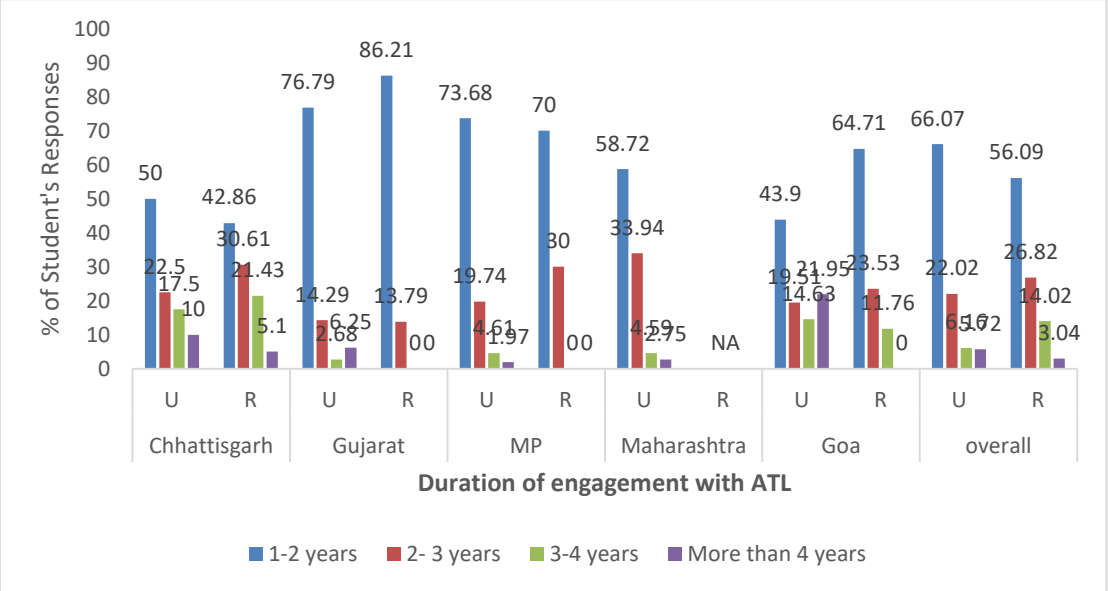


Figure 4.2: State-wise comparison regarding duration of engagement with ATL on the basis of locality

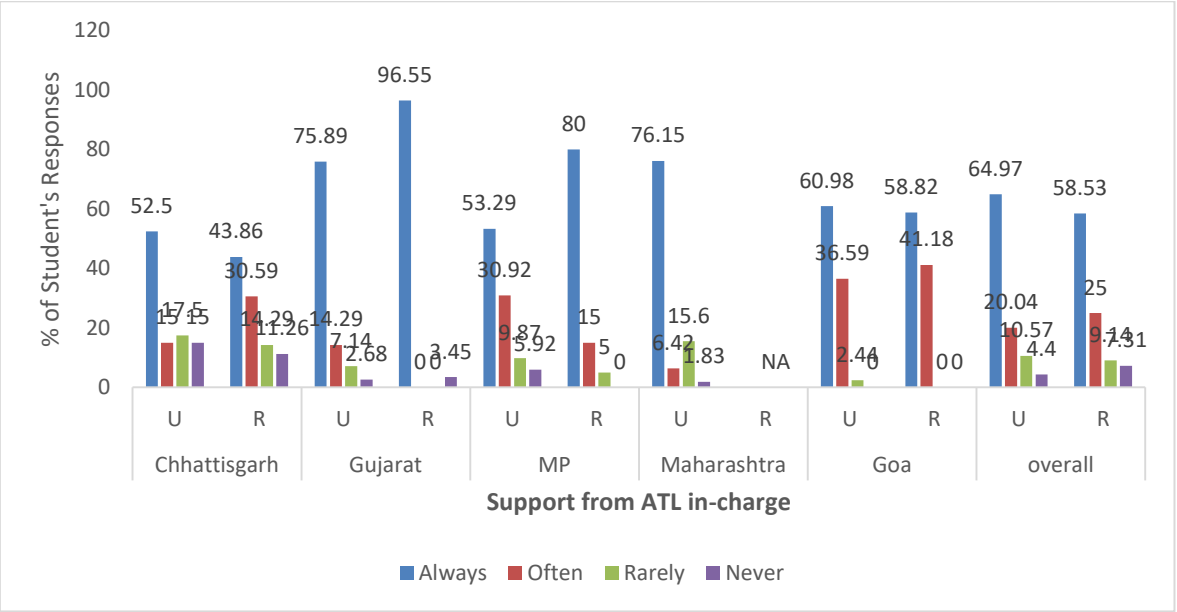


Figure 4.3:State-wise comparison regarding support from ATL in-charge

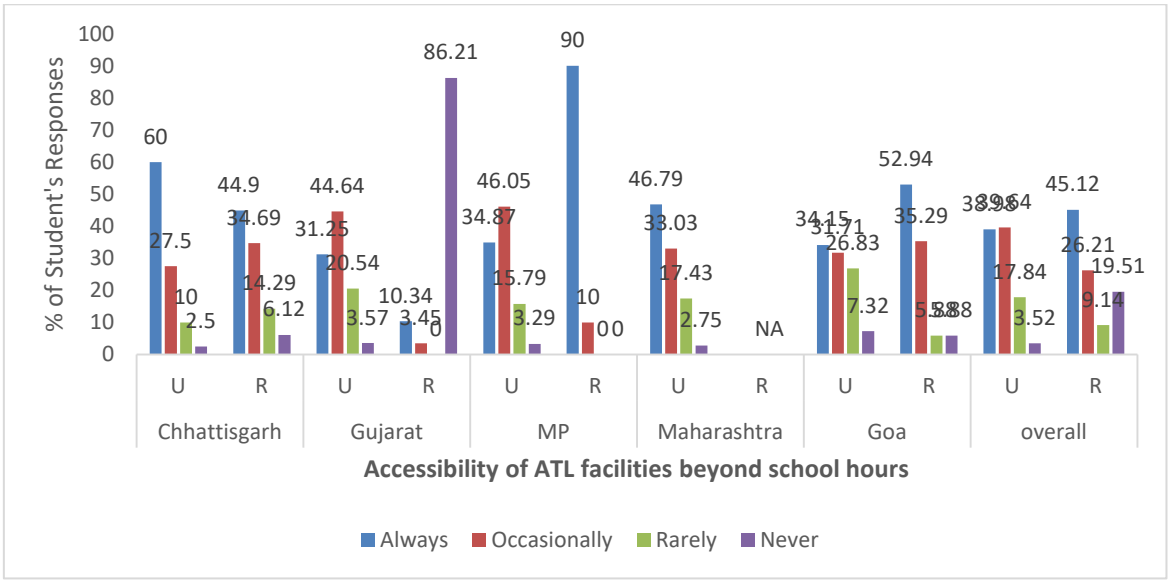


Figure4.4:State-wise comparison regarding accessibility of ATL facilities beyond school hours

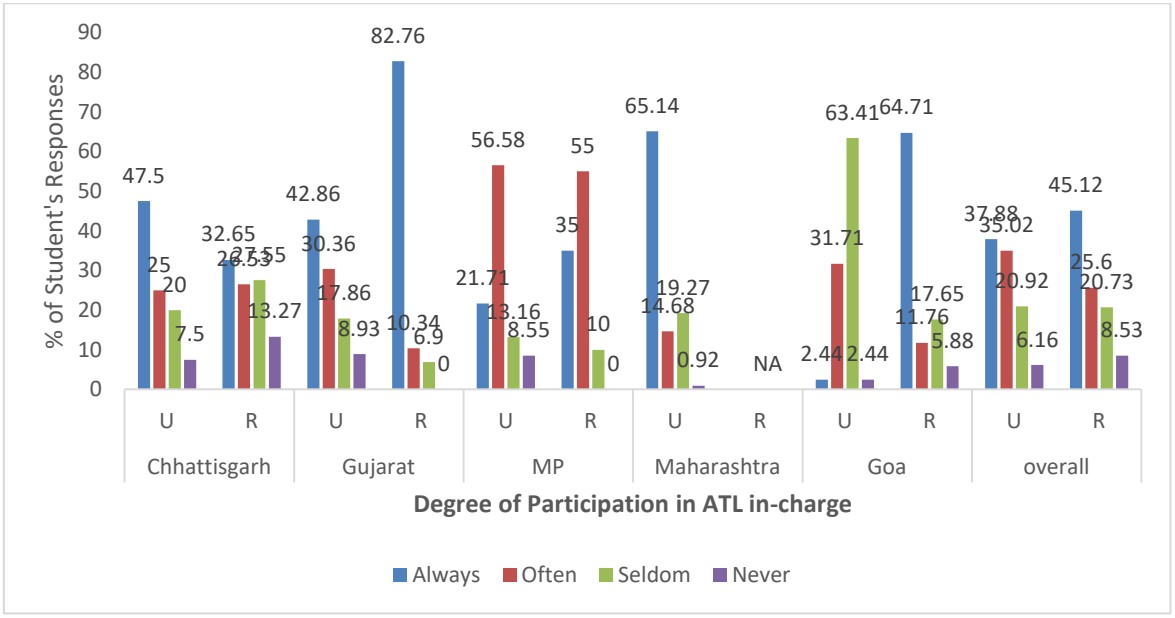


Figure 4.5:Showing degree of participation in ATL in-charge

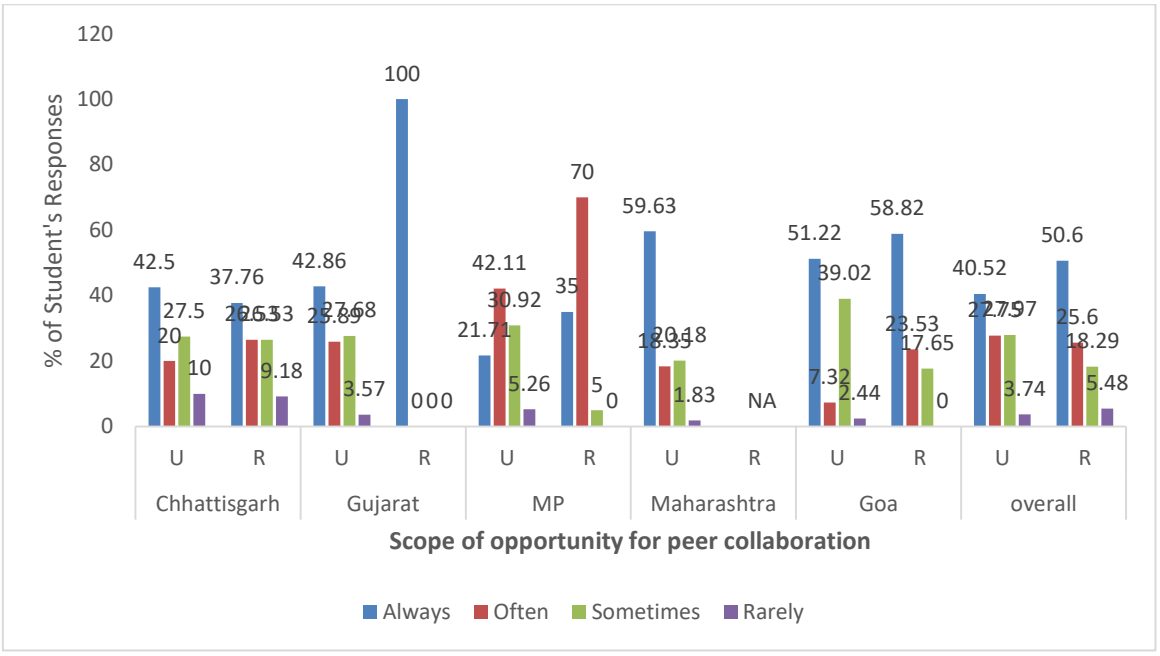


Figure4.6:Scope of opportunity for peer collaboration

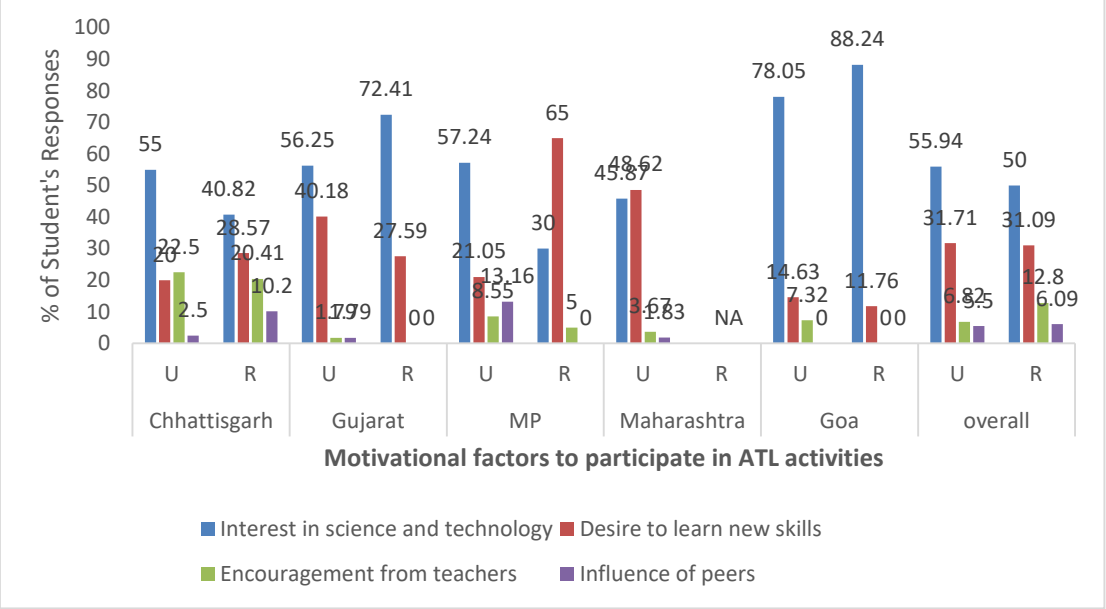


Figure4.7: Showing motivational factors to participate in ATL activities

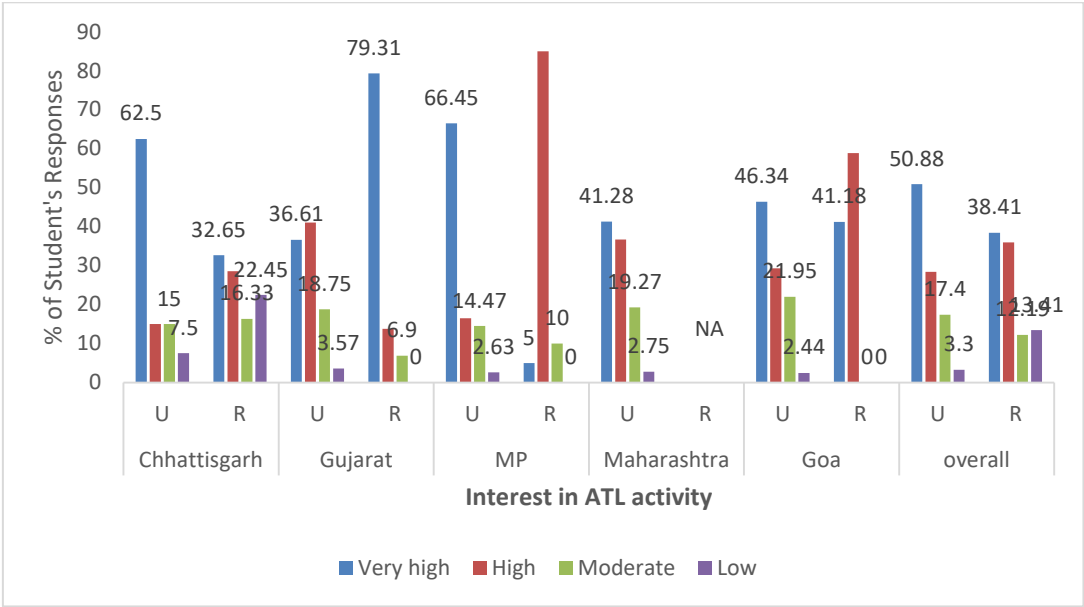


Figure 4.8: Showing interest in ATL activity

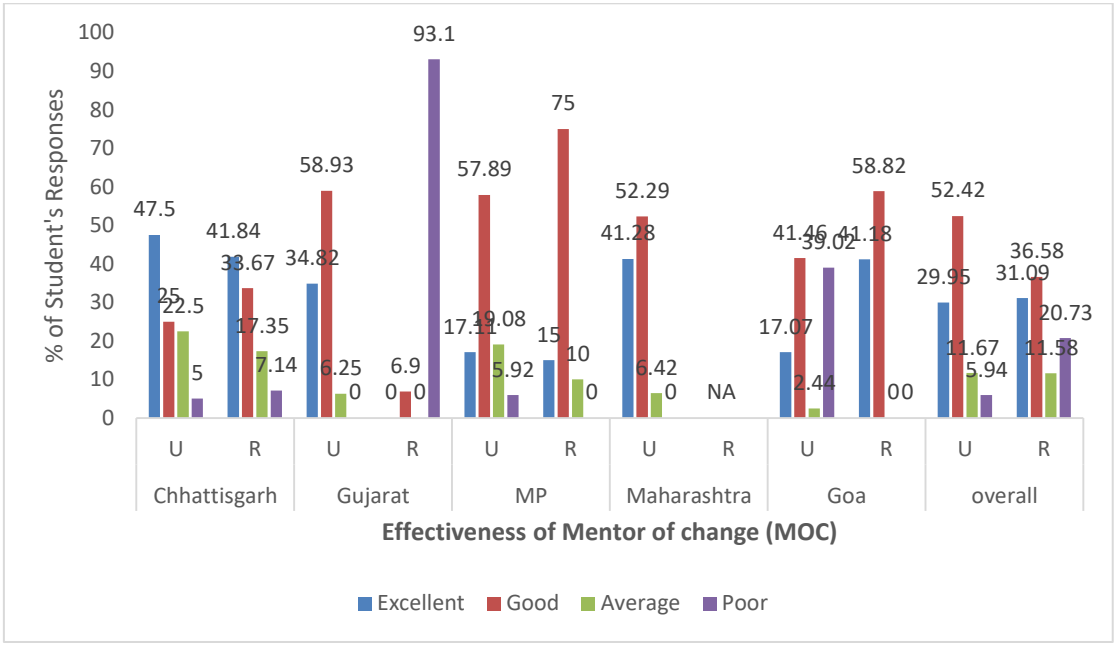


Figure 4.9:Showing effectiveness of mentor of change (MOC)

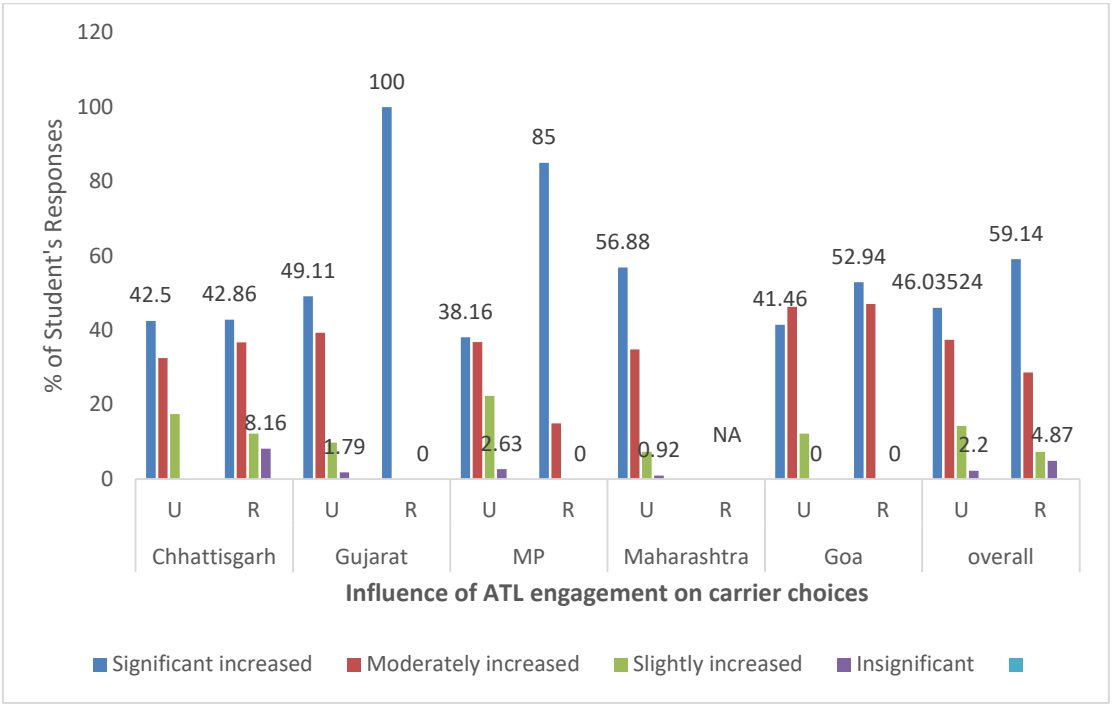


Figure 4.10:Influence of ATL engagement on carrier choices

A comparison of government and private schools was done for Goa and Gujarat states based on the availability of data. Results are presented in Table 4.2. For the frequency of use of ATL it was found that for both Goa and Gujarat that students of private schools mostly attended the ATL weekly(78.38% for Goa and 65.00% for Gujarat). For government schools only 9.52% students

attended the ATL weekly in Goa and for Gujarat it was 50.75%. Most of the students from the government schools of Goa attended the ATL rarely (90.48%).

Most of the students are engaged in ATL activities for a period of 1-2 years for both Goa and Gujarat including both private (56.67%) and government schools (64.58%). Regarding support from ATL in charge most of the students are getting support from ATL in-charge always for both Goa and Maharashtra (73.33% overall).

Accessibility of ATL facilities beyond school hours is available from always to occasionally for both the states as claimed by three fourth of the students. However, for private schools the percentage of accessibility of ATL beyond school hours is higher than government schools for both the states (Goa= 56.76%, Gujarat = 30%). More than 50% students are getting support from ATL in-charge often (31.11%) to always (34.44%). More than half of the students are also collaborating with their peers and in private schools of both Goa (72.97%) and Gujarat (60%) the scope of opportunity for peer collaboration is more. Students from both private and government school show a high level of motivation to participate in ATL activities due to their interest in science and technology in Goa and Gujarat (62.22% overall). The motivation is also affected by the desire to learn new skills for students of both private and government schools in Goa and Gujarat (31.11% overall). More than 50% of the students expressed interest in ATL activities from high (44.44%) to very high range (34.44%) both for government and private schools of Goa and Gujarat. Effectiveness of Mentor of change (MOC) was mostly found good by students of Goa and Gujarat by students of both government (48.67%) and private schools (45.55%). When we compare government and private schools it can be seen that in government schools MOC plays a more effective role. Influence of ATL engagement on carrier choices has significantly increased for more than half of the students in government schools (50%) and 46.66% for private schools for Goa and Gujarat. For government schools in Goa and Gujarat the effect of ATL engagement on career choices has significantly increased more than private schools. The overall statistics is presented in figures 4.11 to 4.20.

Aspects of Functioning						
	GOA		GUJ		overall	
	Govt.	Private	Govt.	Private	Govt	private
1. Use of ATL (1)						
Daily	0.00	8.11	4.76	12.50	25.18	12.22
Weekly	9.52	78.38	47.62	65.00	50.75	70
Monthly	0.00	5.41	38.10	3.33	8.71	11.11
Rarely	90.48	8.11	9.52	19.17	15.34	6.67
2. Duration of engagement with ATL (3)						
1-2 years	76.19	35.14	42.86	85.00	64.58	56.67
2- 3 years	14.29	24.32	23.81	12.50	24.24	17.77
3-4 years	4.76	18.92	4.76	1.67	7.95	10
More than 4 years	4.76	21.62	28.57	0.83	3.21	15.55
3. Support from ATL in-charge (9)						
Always	38.10	72.97	61.90	83.33	61.55	73.33
Often	57.14	27.03	14.29	10.83	21.78	18.88
Rarely	4.76	0.00	14.29	4.17	10.98	5.55
Never	0.00	0.00	9.52	1.67	5.68	2.22
4. Accessibility of ATL facilities beyond school hours (8)						
Always	9.52	56.76	9.52	30.00	40.71	40
Occasionally	28.57	35.14	57.14	32.50	33.90	48.88
Rarely	47.62	5.41	28.57	14.17	16.66	8.88
Never	14.29	2.70	4.76	23.33	8.71	2.22
5. Degree of Participation in ATL in-charge (6)						
Always	0.00	32.43	38.10	53.33	40.71	34.44
Often	23.81	27.03	28.57	25.83	32.76	31.11
Seldom	76.19	35.14	28.57	13.33	19.50	28.88
Never	0.00	5.41	4.76	7.50	7.00	5.55
6. Scope of opportunity for peer collaboration (11)						
Always	19.05	72.97	23.81	60.00	41.66	52.22
Often	9.52	13.51	19.05	20.83	28.21	21.11111
Sometimes	66.67	13.51	57.14	15.83	25.56	24.44
Rarely	4.76	0.00	0.00	3.33	4.54	2.22

7. Motivational factors to participate in ATL activities (5)						
Interest in science and technology	85.71	78.38	33.33	64.17	53.03	62.22
Desire to learn new skills	14.29	13.51	66.67	32.50	31.62	31.11
Encouragement from teachers	0.00	8.11	0.00	1.67	9.09	4.44
Influence of peers	0.00	0.00	0.00	1.67	6.25	2.22
8. **Interest in ATL activity (4)**						
Very high	57.14	37.84	28.57	48.33	49.81	34.44
High	23.81	45.95	57.14	31.67	28.03	44.44
Moderate	19.05	13.51	9.52	17.50	15.71	17.77
Low	0.00	2.70	4.76	2.50	6.43	3.33
9. **Effectiveness of Mentor of change (MOC)** (10)						
Excellent	23.81	24.32	4.76	31.67	29.73	33.33
Good	71.43	32.43	85.71	41.67	48.67	45.55
Average	4.76	0.00	9.52	4.17	13.06	3.33
Poor	0.00	43.24	0.00	22.50	8.52	17.77
10. Influence of ATL engagement on carrier choices (12)						
Significant increased	66.67	32.43	66.67	58.33	50	46.66
Moderately increased	28.57	56.76	28.57	31.67	33.52	44.44
Slightly increased	4.76	10.81	0.00	8.33	13.25	7.77
Insignificant	0.00	0.00	4.76	1.67	3.21	1.11

Table 4.2: Response of secondary school students (%) on various aspects of functioning of ATL for private and government schools of Goa and Gujarat

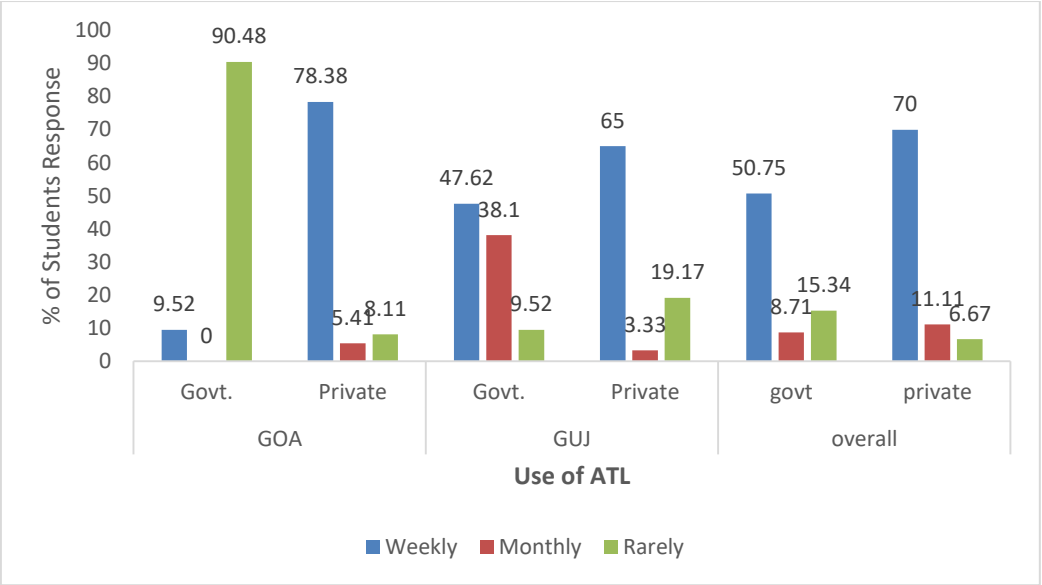


Figure 4.11: State-wise comparison regarding use of ATL on the basis of nature of management

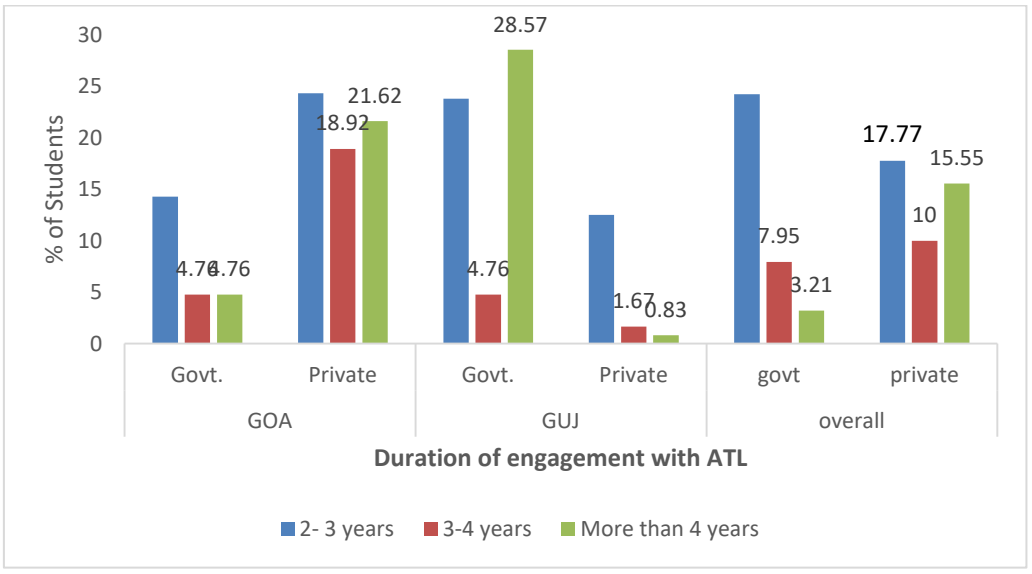


Figure 4.12: State-wise comparison regarding duration of engagement with ATL on the basis of nature of management

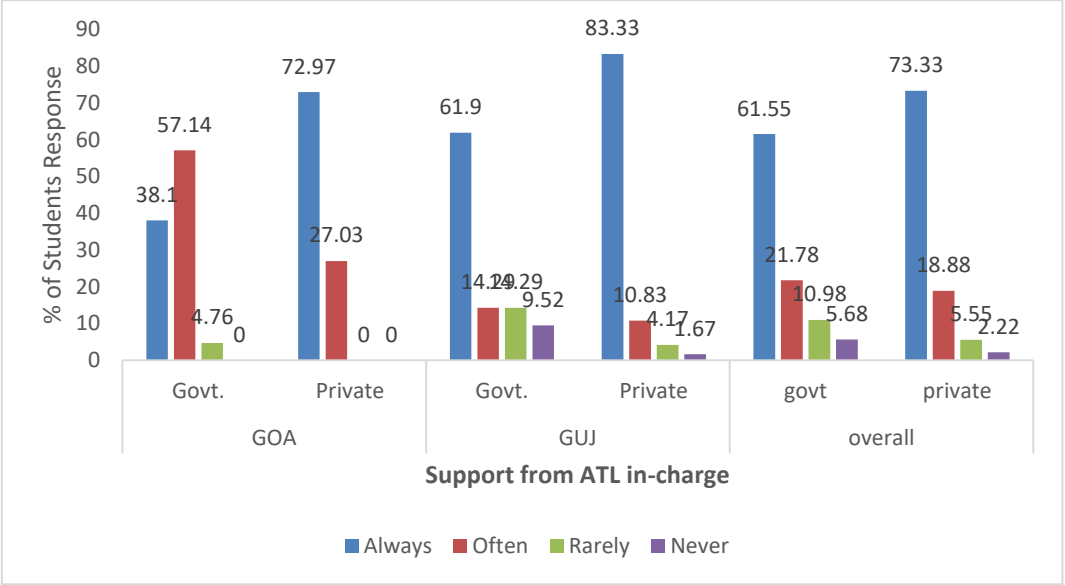


Figure 4.13: Support from ATL in-charge on the basis of nature of management

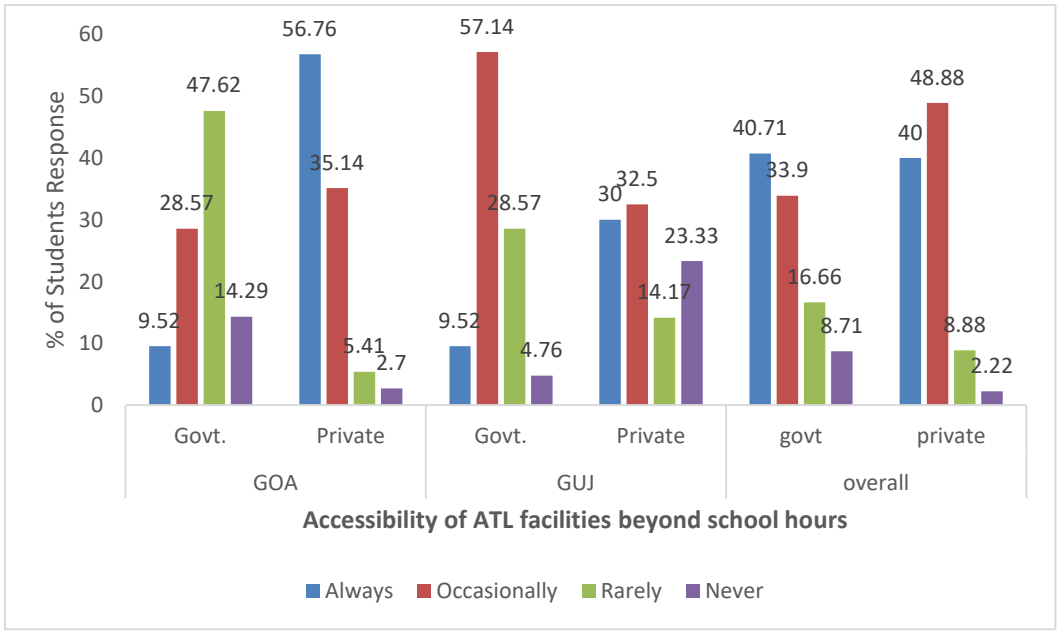


Figure 4.14: Accessibility of ATL facilities beyond school hours

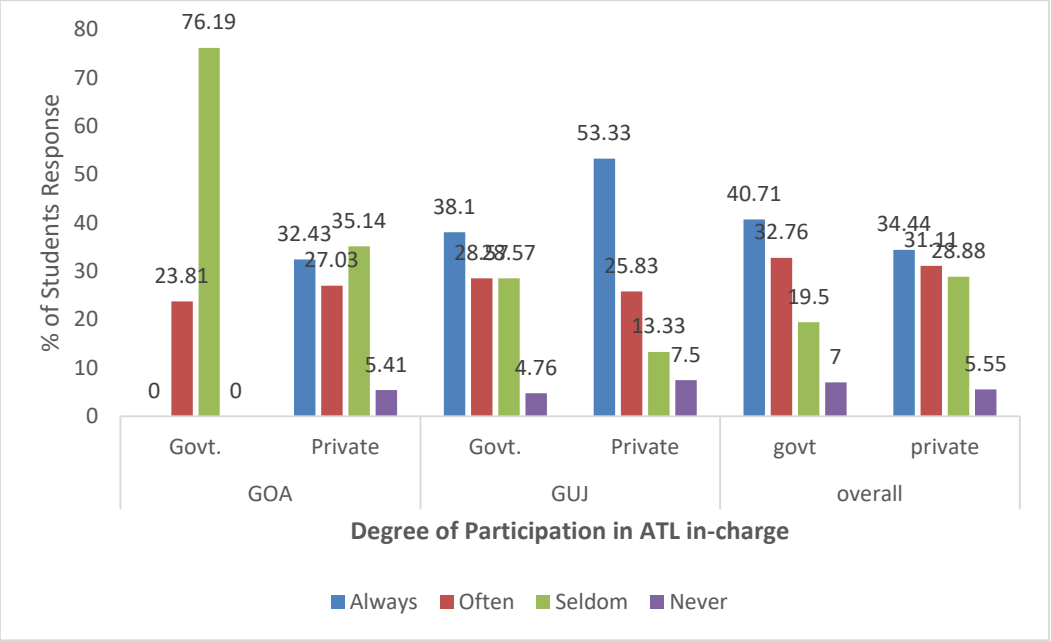


Figure 4.15: Showing degree of participation of ATL in-charge

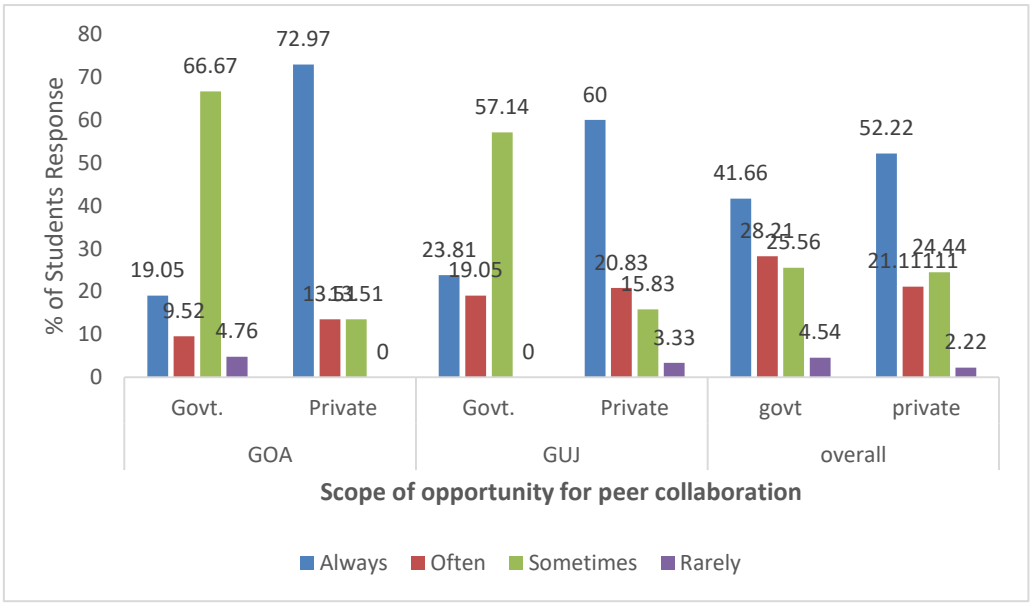


Figure 4.16: Showing scope of opportunity for peer collaboration

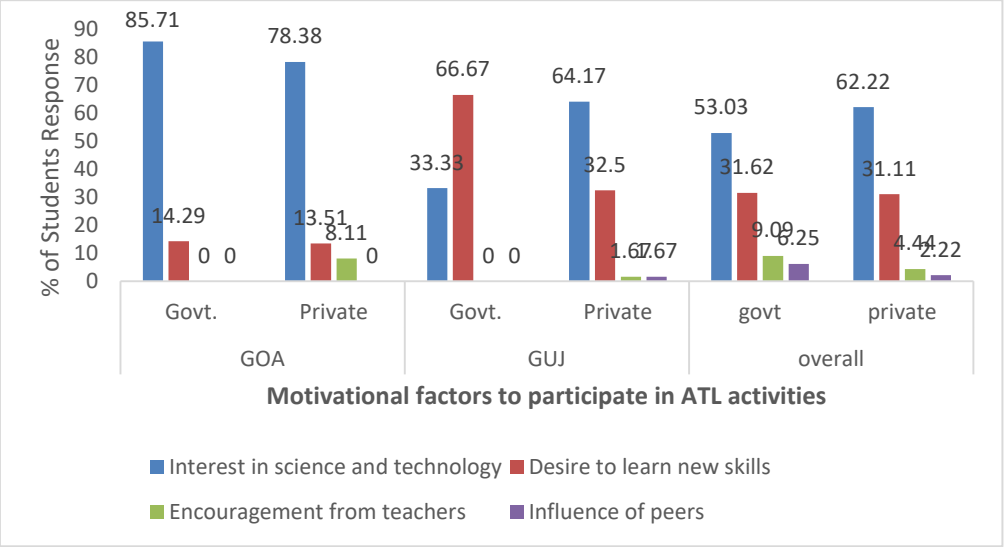


Figure 4.17: Showing motivational factors to participate in ATL activities

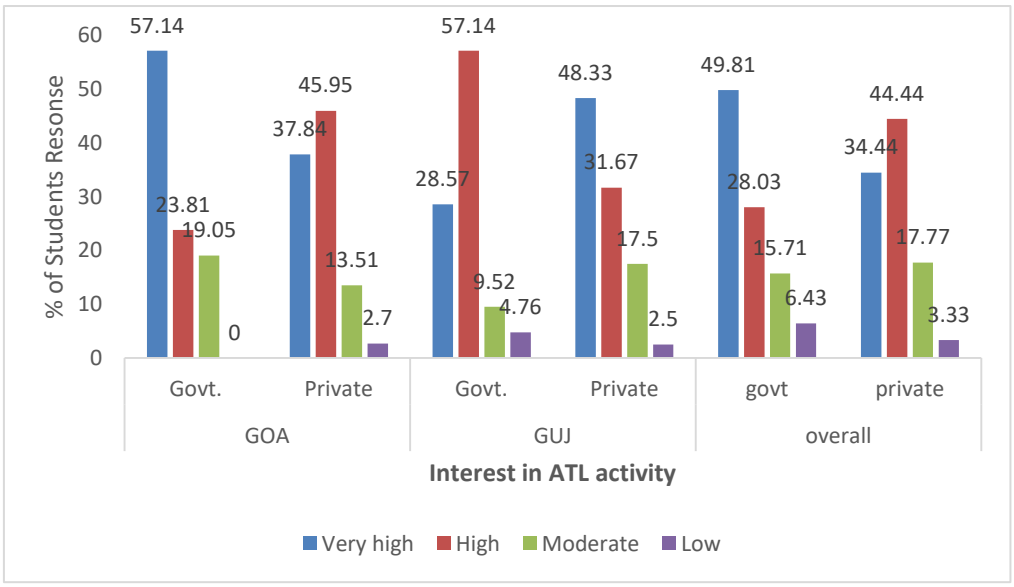


Figure 4.18: Showing interest in ATL activity on the basis of nature of management

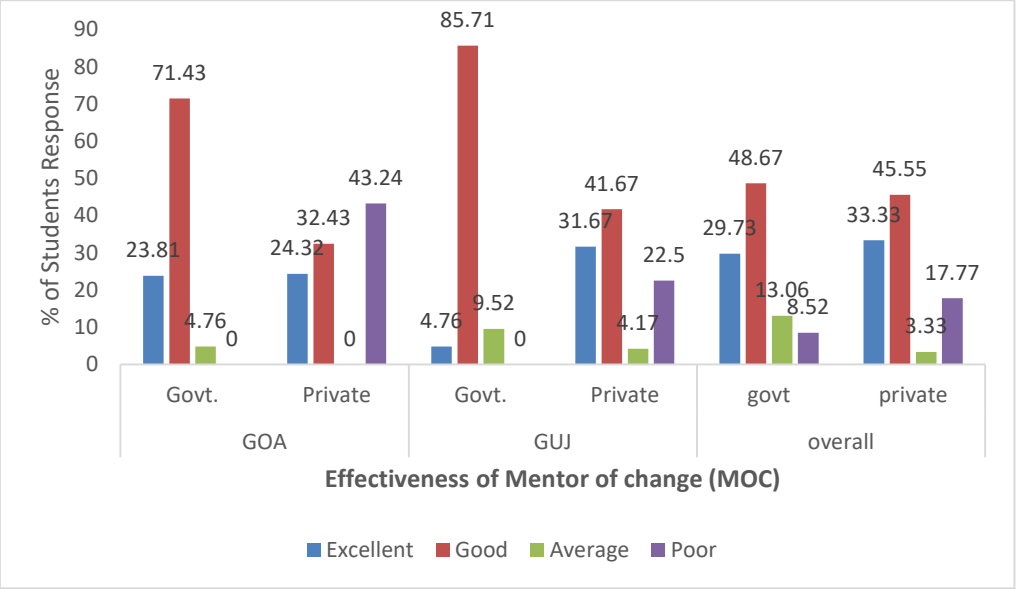


Figure 4.19: Showing effectiveness of mentor of change (MOC) on the basis of nature of management

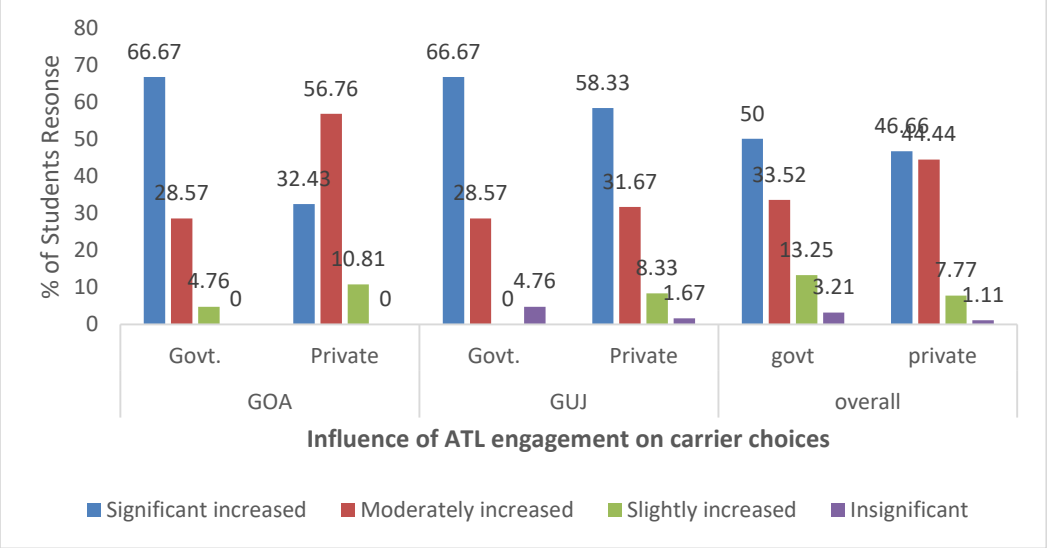


Figure 4.20: Showing influence of ATL engagement on carrier choices

DISCUSSION

The results on the status of usage and interest in ATL activities for various states of the western region of India, focusing on student engagement in both rural and urban schools is presented in Tables 4.1. The results highlight that the highest daily usage of ATL is in urban schools in Chhattisgarh, with a significant number of students participating weekly. It was also found that most students engage in ATL activities for 1-2 years and receive consistent support from ATL in-charges. Accessibility of ATL facilities beyond school hours is relatively high, particularly in rural Madhya Pradesh. Regarding the motivational factors for participation a strong interest in science and technology was the highest contributing factor, and it was also found that there was a moderate positive influence of ATL engagement on students' career choices. This reconfirms the idea that ATL can promote STEM education by providing support across all STEM domains. Over the past decade, STEM education in India has experienced extraordinary development and transformation. Both the public and commercial sectors have made significant expenditures to improve STEM infrastructure and curricula because they understand how crucial STEM fields are to fostering innovation and economic growth. ATL can serve as a **catalyst for STEM education** by providing students with hands-on learning opportunities and fostering an **innovation-driven mindset (Mishra and Gupta, 2023).** These labs bridge the gap between theoretical knowledge and practical application, encouraging students to explore STEM fields through experimentation, problem-solving, and real-world projects.

Results of government and private schools in Goa and Gujarat, focusing on student engagement in ATL (Atal Tinkering Lab) activities are presented in Table 4.2. The results highlight the frequency of participation in ATL, support from ATL in-charges, accessibility of facilities, peer collaboration, motivation levels, and the influence of ATL engagements on career choices. The findings reveal that private school students in both states engage more frequently in ATL activities compared to government school students, with notable differences in support and accessibility levels.In comparing Goa and Gujarat, it was found that there are differences in student participation in ATL activities between the two states. For private schools, the frequency of attending ATL weekly is higher in Goa (78.38%) than in Gujarat (65.00%). In contrast, for government schools, the attendance is lower in Goa (9.52%) compared to Gujarat (50.75%). It was found that most of the students from the government schools of Goa attended ATL rarely (90.48%). Additionally, the accessibility of ATL facilities beyond school hours is noted to be higher in private schools than in government schools for both states, with Goa showing 56.76% and Gujarat 30% for private schools. It was also found that students from both private and government school show a high level of motivation to participate in ATL activities due to their

interest in science and technology in Goa and Gujarat (62.22% overall) which is similar to the results of different states based on locale.

4.2RESULTS OF OBJECTIVE-1

Objective 1:To study the status of the use of ATL in Secondary Schools of Western Region in India, i.e. the study area(From teachers' perspective)

4.2.1 FUNCTIONING OF ATALS: FROM THE PERSPECTIVE OF TEACHERS

INTRODUCTION

Teachers play a critical role in the success of Atal Tinkering Labs (ATLs), acting as facilitators, mentors, and guides for students exploring innovation, STEM learning, and entrepreneurship. Their perspective on ATL functioning provides valuable insights into challenges, opportunities, and best practices in implementing ATL effectively.The perspective of teachers on the use of ATL is given in this section. Data for this study was collected using **Tool no.4 , in Annexure D, i.e; To study the status of the use of Atal Tinkering Labs (ATLs) in Secondary Schools of the Western Region in India**from ATL in-charges.

The following aspects of functioning of ATL were used for the study

1. Available functional infrastructure- Ensuring availability of essential equipment like 3D printers, robotics kits, IoT modules, and AI tools.
2. Level of grant received- The Atal Tinkering Labs (ATL) grant-in-aid is disbursed in three tranches by the Atal Innovation Mission (AIM), NITI Aayog to selected schools. The total approved funding is ₹20 lakh, which is divided into three tranches. Submission of Utilization Certificate (UC) & Progress Report for the previous tranche.Successful submission of all previous Utilization Certificates (UC), progress reports, and ATL activity evidence.
3. Level of thematic integration of science and technology with ATL- Connecting ATL activities with subjects like Science, Math, Computer Science, and Entrepreneurship.
4. Degree of understanding of specified concepts compliance with ATL- Opportunities given to children to work with relevant tools and equipment in ATL to understand the concepts of – robotics, IoT, 3-D Printing, basic electronics, product prototyping, and arts and crafts.

5. MOU with other academic partnership- A Memorandum of Understanding (MoU) between Atal Tinkering Labs (ATL) and academic institutions plays a crucial role in enhancing innovation, knowledge exchange, and skill development. Partnerships with universities, research institutes, and technical colleges provide students with access to advanced learning resources, mentorship, and industry exposure.

6. Influence of ATL on students' attitude towards higher education- The Atal Tinkering Lab (ATL) initiative fosters experiential learning, innovation, and problem-solving, which significantly influences students' attitudes toward higher education, career aspirations, and STEM disciplines. By providing hands-on exposure to technology, entrepreneurship, and research, ATL encourages students to pursue higher studies in science, engineering, and innovation-driven fields.

With respect to the above aspects of functioning of ATL data obtained from five states of western region is presented in Table 4.3. Under the available functional infrastructure in schools most of the ATL in charges have reported the availability of electronics, robotic and IOT (86.95%, rapid prototyping (86.95%), mechanical, electrical and measurement tools (91.30%), power supply, accessories and safety tools (91.30%). All the schools have received the Tranche 1 grant (100%) whereas only 31.3% have received Tranche 2 grant. None of the schools were successful in receiving Tranche 3 grant. Through ATL teachers were able to thematically integrate the concepts of science and technology from the curriculum for very effectively it was 52.17% , moderately effective it was 43.47%, and not at all effectively it was 4.34%.

With regards to the 52.17% ATL in-charges reported that they could integrate the concepts of science and technology from the curriculum with ATL activities in a very effective manner. 43.47% reported that the integration was moderately effective whereas 4.34% reported that integration was not at all done in an effective manner. With regard to degree of understanding of specified concepts compliance with ATL which covers how effectively children are involved with ATL offered opportunities to work with relevant tools and equipment to understand the concepts of – robotics, IoT, 3-D Printing, basic electronics, product prototyping, and arts and crafts 60.86% find it very effectively done, 34.78% find moderately effectively done and 4.34% find not effectively done at all. Only 26.08% ATL in-charges reported that the school has MOU with other institutions. The influence of ATL of the school in helping the students to shape better prospects in terms of – attaining higher education, vocational skill development, job, and entrepreneurship (start-ups, influencers, etc.) 69.57% find it to be very effective, 26.09% find it moderately effective and 4.34% find not effective at all.

With regard to status of academic leadership influencing ATL implementation 26.08 % ATL in charges rate their academic leadership excellent in implementing the ATL Project effectively, whereas 65.22% rate their academic leadership to be good in implementing the ATL Project effectively and 8.70%rate their academic leadership to be average in implementing the ATL

Project effectively. The overall statistics of the aspects of functioning of ATL is given in Table 4.3 and in figure 4.21.

Aspects of Functioning	Response of secondary schools ATL in-charge
	Overall
1. Available functional infrastructure	
Electronics, robotic and IOT	86.95
Rapid prototyping	86.95
Mechanical, electrical and measurement tools	91.30
Power supply, accessories and safety	91.30
2. Level of grant received	
Tranche 01	100
Tranche 02	31.13
Tranche 03	0
3. Level of thematic integration of science and technology with ATL	
Very effective	52.17
Moderate effective	43.47
Not effective	4.34
4. Degree of understanding of specified concepts compliance with ATL	
Very effective	60.86
Moderate effective	34.78
Not effective	4.34
5. MOU with other academic partnership	
Having MOU sign	26.08
6. Influence of ATL on students' negative towards higher education	
Very effective	69.57
Moderate effective	26.09
Not effective	4.34
7. Status of academic leadership influencing ATL implementation	
Excellent	26.08
Good	65.22
Average	8.70

Table 4.3: Response of secondary schools ATL in-charge on different aspects of functioning of ATL

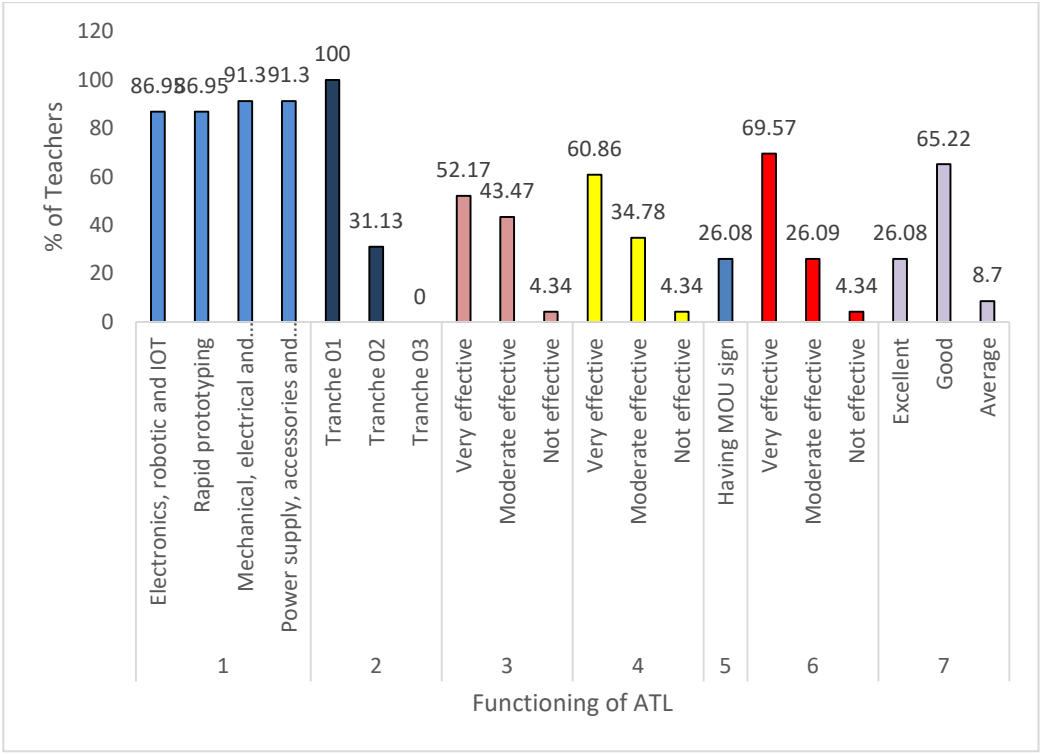


Figure 4.21: The overall statistics of the aspects of functioning of ATL represented in the form of bar diagrams (N=23)

The engagement of students in ATL (Atal Tinkering Lab) programs follows a structured yet flexible pattern, allowing students to explore STEM, innovation, and entrepreneurship through hands-on learning. Their participation varies based on interest, skill level, and exposure to different ATL activities. Different kinds of ATL activities and participation of students from different schools is given in Table 4.4. Based on the statistics presented in the table most of the schools have organized Workshop and seminars Online Achievement Day. A moderate level of participation was seen in visits undertaken by students to industries, innovations registered with AIM. And Low participation was observed in programs like AIM Hackathon ATL Tinkerpreneur, Intellectual Property Rights granted and under process. The overall statistics is presented in the form of bar diagrams in Figure 4.22

S.No.	Activity/Programme	Nature of participation of schools
1	AIM Hackathon	9 (39.13%)
2	ATL Tinkerpreneur	7 (30.43%)
3	Innovations registered with AIM	10 (43.47%)
4	Innovations registered in the top list of marathons with AIM	8 (34.78%)
5	Intellectual Property Rights granted	2 (8.69%)
6	Intellectual Property Rights under process	4 (17.39%)
7	Workshop and seminars conducted	17 (73.91%)
8	Expert talk conducted	15 (65.21%)
9	Online interaction session	17 (73.91%)
10	offline interaction session	16 (69.56%)
11	Participation in exhibition	17 (73.91%)
12	Achievement day celebration	18 (78.26%)
13	Number of visits of ATL team for industry institution programme	10 (43.47%)

Table: 4.4: Overall pattern of engagement of the students in different ATL related programs based on data collected from ATL in-charges (N=23)

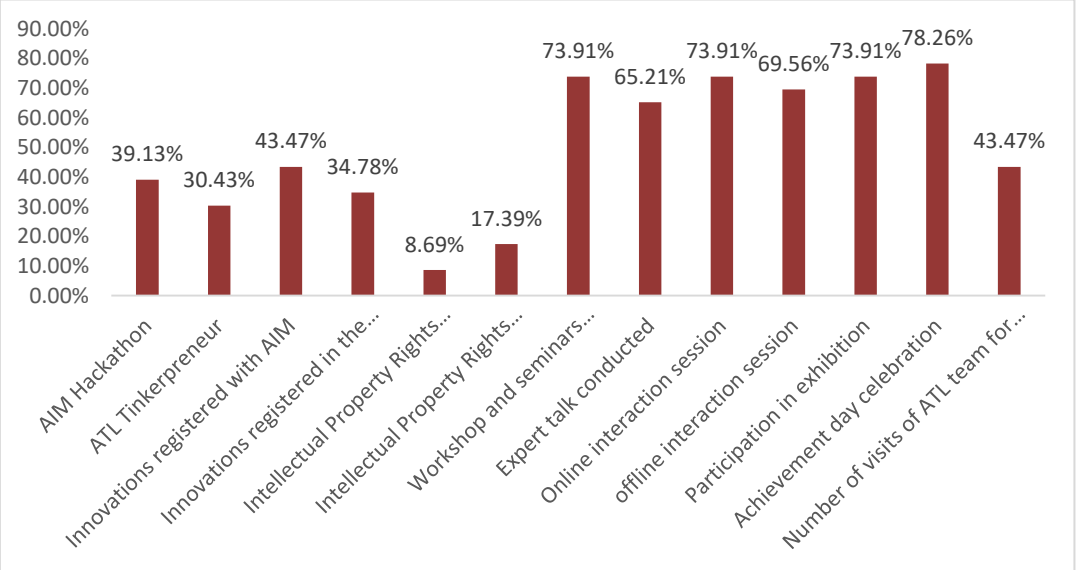


Figure 4.22: Overall statistics of engagement of the students in different ATL related programs based on data collected from ATL in-charges (N=23)

The data has also been analyzed on the basis of functioning of ATL in rural and urban schools of Western Region. The results pertaining to functioning of ATL in secondary schools of Western Region based on local are presented in table 4.3. The data was collected from 23 (Urban= 16 and Rural= 7) teachers in-charges of ATL on 7 parameters of functioning such as 1,2,3,4,5,6,7 were analyzed and presented as follow.

More than three fourth of teachers working in both urban and rural schools (85.71% and 81.25% respectively) have reported that electronic, robotic and IOT are functional in the laboratories in their respective school. The corresponding figure for availability of functional infrastructure such as rapid prototyping (75% and 85.71% respectively); mechanical, electrical and measurement tools (891.25% and 100% respectively); power supply, accessories and safety (81.25% and 100% respectively).

All the schools (100%) both rural and urban have received the Tranche 1 grant. Majority of urban schools have received Tranche 2 grant (85.71%) whereas for rural schools it is only 18.75%. None of the schools have received Tranche 3 grant.

42.85 % ATL in-charges in urban areas reported that they could integrate the concepts of science and technology from the curriculum with ATL activities in a very effective manner. Whereas for rural areas it was 56.25%. For urban areas 57.14 % reported the integration was moderately effective whereas in rural areas it was 37.5%. For rural areas 6.25% reported that integration was not at all done in an effective manner. With regard to degree of understanding of specified concepts compliance with ATL which covers how effectively children are involved with ATL offered opportunities to work with relevant tools and equipment to understand the concepts of – robotics, IoT, 3-D Printing, basic electronics, product prototyping, and arts and crafts71.43 in urban areas find effective for rural areas it was 56.25%. In urban areas 28.57% find moderately effective and in rural areas it was 37.5%. For rural areas 6.25% reported that degree of compliance was not at all done in an effective manner.

Only 42.86% ATL in-charges in urban areas reported that the school has MOU with other institutions whereas for rural areas it was 31.25%. With reference to the influence of ATL of the school in helping the students to shape better prospects in terms of – attaining higher education, vocational skill development, job, and entrepreneurship (start-ups, influencers, etc.) 85.71 % for urban areas and 56.25% for rural areas find it effective, 14.29% for urban areas and 31.25% find it moderately effective. For rural areas 6.25% ATL charges reported that influence was not at all effective.

With regard to status of academic leadership influencing ATL implementation42.86 % ATL in charges rate their academic leadership excellent in implementing the ATL Project effectively for rural areas it was low (18.75%). Again, in urban areas 42.86% rate their academic leadership to be good which is higher for rural areas (75%) in implementing the ATL Project effectively. In urban areas14.28% and for rural areas 6.25% rate their academic leadership to be average in implementing the ATL Project effectively. The overall statistics of the aspects of functioning of ATL on the basis of locale is given in Table 4.5 and Figures 4.23 to 4.28.

Aspects of Functioning	Response of secondary schools ATL in-charge	
	Overall	
	Rural	Urban
1. Available functional infrastructure		
Electronics, robotic and IOT	81.25	85.71
Rapid prototyping	75	85.71
Mechanical, electrical and measurement tools	81.25	100
Power supply, accessories and safety	81.25	100
2. Level of grant received		
Tranche 01	100	100
Tranche 02	18.75	85.71
Tranche 03	0	0
3. Level of thematic integration of science and technology with ATL		
Very effective	56.25	42.85
Moderate effective	37.5	57.14
Not effective	6.25	0

4. Degree of understanding of specified concepts compliance with ATL		
Very effective	56.25	71.43
Moderate effective	37.5	28.57
Not effective	6.25	0
5. MOU with other academic partnership		
Having MOU sign	31.25	42.86
6. Influence of ATL on students' negative towards higher education		
Very effective	56.25	85.71
Moderate effective	31.25	14.29
Not effective	6.25	0
7. Status of academic leadership influencing ATL implementation		
Excellent	18.75	42.86
Good	75	42.86
Average	6.25	14.28

Table 4.5: Functioning of ATL in Secondary Schools of Western Region on the basis of Locale(Urban (N) = 16; Rural (N) = 7)

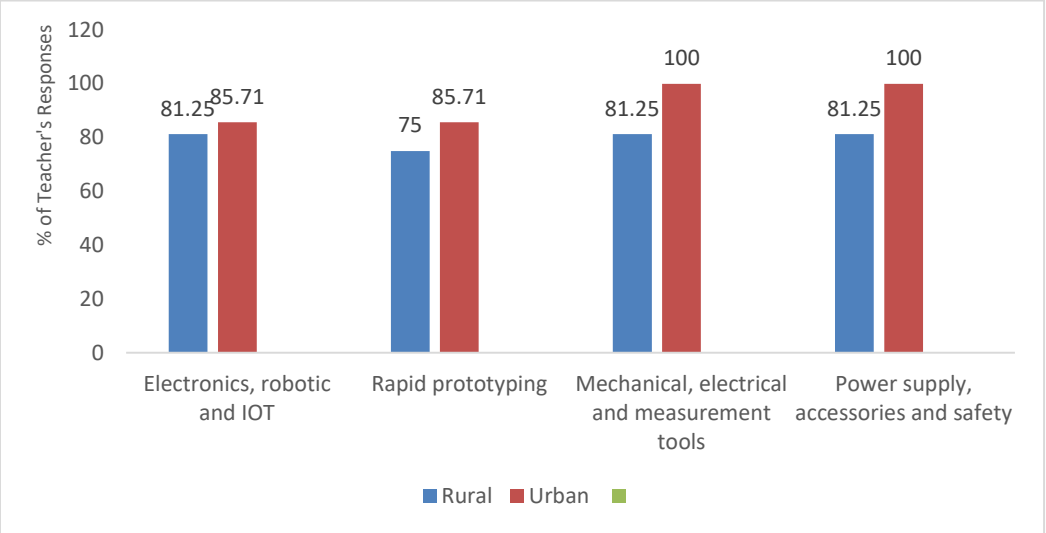


Figure 4.23: Available functional infrastructure in terms of specified indicators

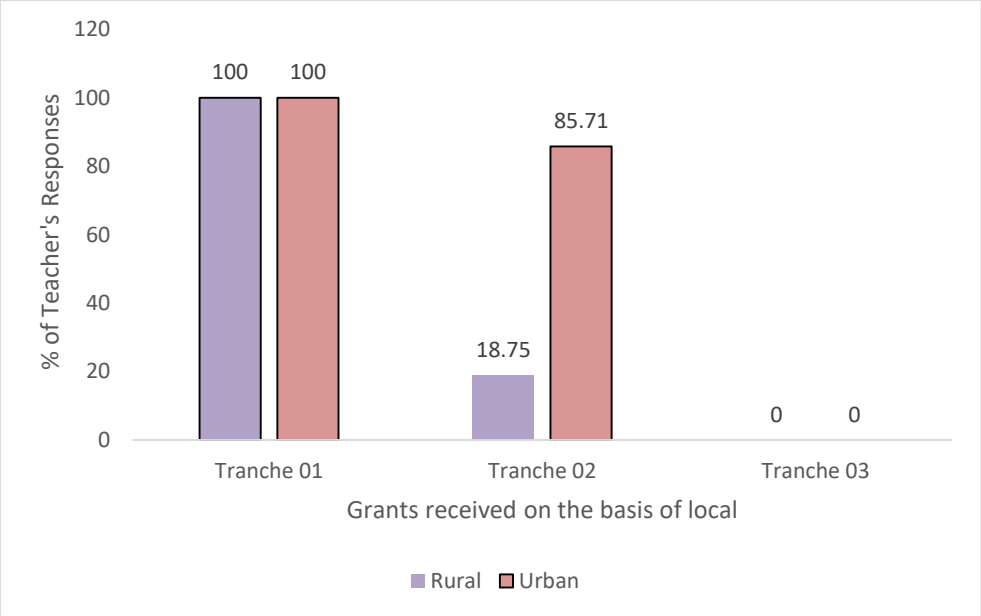


Figure 4.24: Level of grant received in terms of parameters

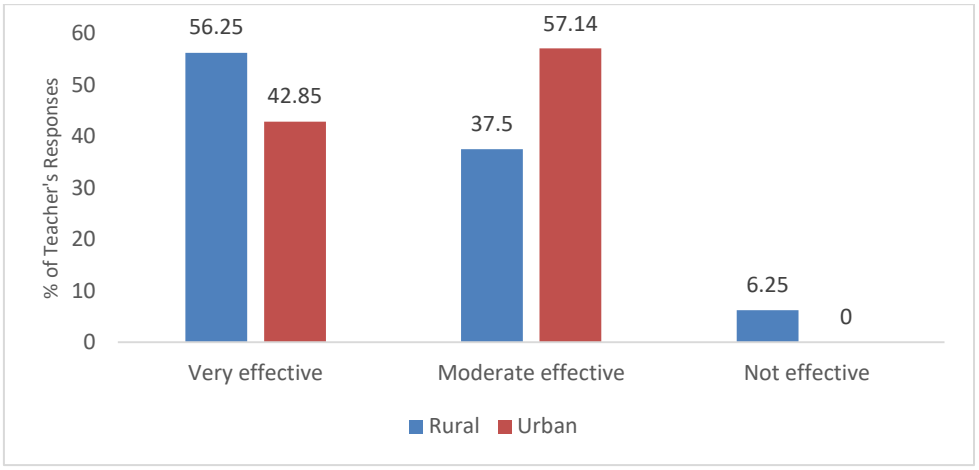


Figure 4.25: Level of thematic integration of science and technology with ATL

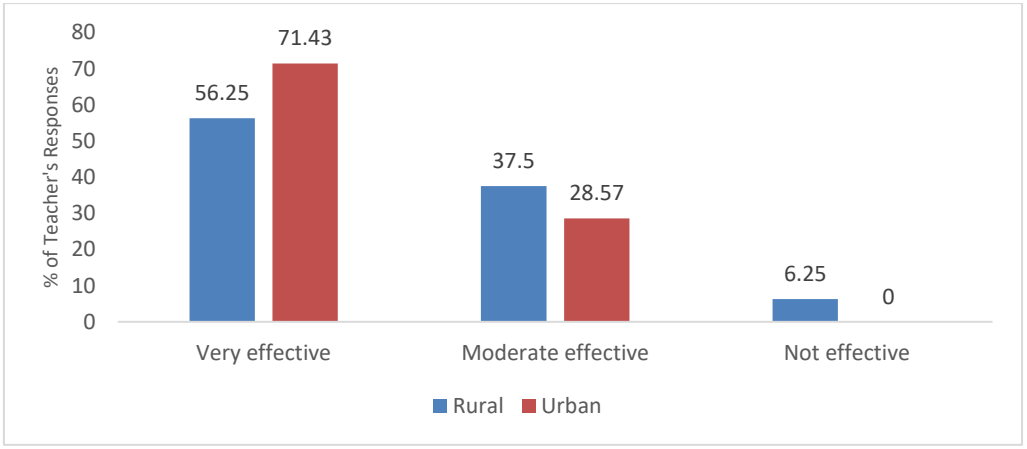


Figure 4.26: Degree of understanding of specified concepts compliance with ATL

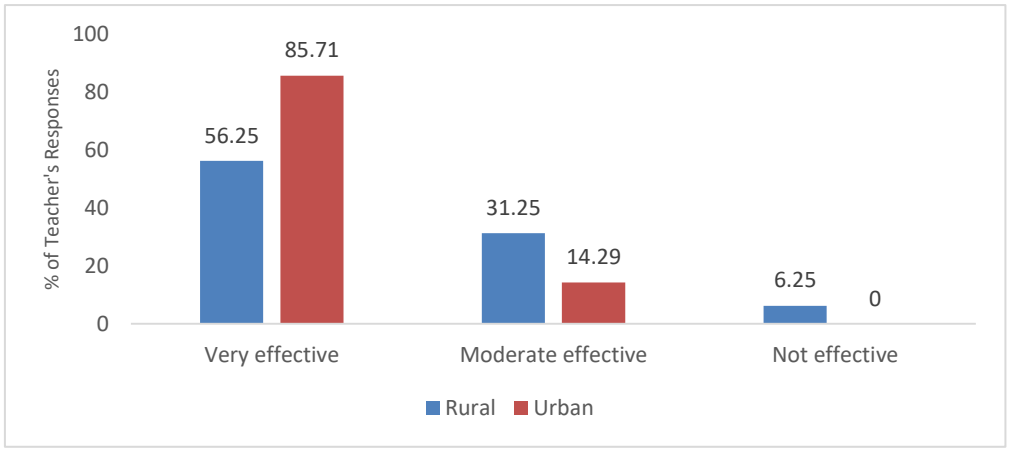


Figure 4.27: Influence of ATL on students' attitude towards higher education

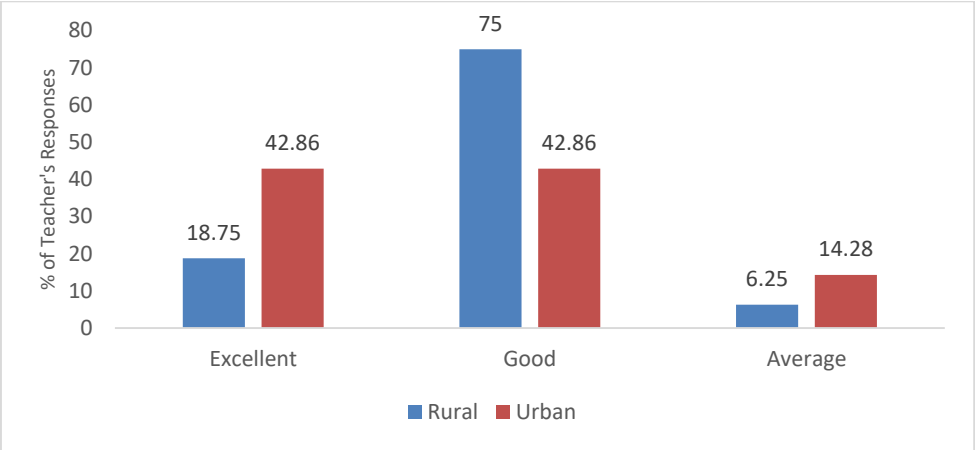


Figure 4.28: Status of academic leadership influencing ATL implementation

The data has also been analyzed on the basis of nature of management in Western Region. The results pertaining this are presented in table 4.4. (Govt. (N) = 18; Private (N) = 5) teachers in-charges of ATL on 7 parameters of functioning such as 1,2,3,4,5,6,7 was analyzed and presented as follow.

All the private school teachers (100%) reported that they have all available functional infrastructure in the lab corresponding to Electronics, robotic and IOT, Rapid prototyping, Mechanical, electrical and measurement tools, Power supply, accessories and safety equipment.
For government schools 77.78% reported the availability of Electronics, robotic and IOTdevices, 72.22% reported the availability of rapid prototyping devices, 88.89% reported the availability of mechanical, electrical and measurement tools, 88.89 % reported availability of power supply, accessories and safety tools.

All the schools (100%) both government and private have received the Tranche 1 grant. Majority of private schools have received Tranche 2 grant (80%) whereas for government schools it is only 27.78%. None of the schools have received Tranche 3 grant.

60% ATL in-charges inprivate schools reported that they could integrate the concepts of science and technology from the curriculum with ATL activities in a very effective manner. Whereas for government schools it was 50%. For private schools40% reported the integration was moderately effective whereas in government schools it was 44.44%. For government schools 5.56% reported that integration was not at all done in an effective manner.

With regard to degree of understanding of specified concepts compliance with ATL which covers how effectively children are involved with ATL offered opportunities to work with relevant tools and equipment to understand the concepts of – robotics, IoT, 3-D Printing, basic electronics, product prototyping, and arts and crafts60% in private schools find very effective compliance and for government schools it was 56.25%. In private schools40% find moderately effective and in government schools it was 33.33%. For government schools 5.56% reported that degree of compliance was not at all done in an effective manner.

60% ATL in-charges in private schools reported that the school has MOU with other institutions whereas for government schools it was 16.67%

With reference to the influence of ATL of the school in helping the students to shape better prospects in terms of – attaining higher education, vocational skill development, job, and entrepreneurship (start-ups, influencers, etc.)80 % for private schools and 66.67 % for government schools find it effective, 20% for private schools and 27.77% for government schools find it moderately effective. For government schools5.56%ATL charges reported that influence was not at all effective.

With regard to status of academic leadership influencing ATL implementation 20 % ATL in charges in private schools rate their academic leadership excellent in implementing the ATL Project effectively for government schoolsit was low (27.78%). Again, in private schools 80 % rate their academic leadership to be good and for government schools it is 66.66%in implementing the ATL Project effectively. For government schools5.56 % rate their academic leadership to be average in implementing the ATL Project effectively. The overall statistics of the aspects of functioning of ATL on the basis of locale is given in Table 4.6 and Figures 4.29 to 4.30.

Aspects of Functioning	Response of secondary schools ATL in-charge	
	Overall	
	Govt.	Private
1. Available functional infrastructure		
Electronics, robotic and IOT	77.78	100
Rapid prototyping	72.22	100
Mechanical, electrical and measurement tools	88.89	100

Power supply, accessories and safety	88.89	100
2. Level of grant received		
Tranche 01	100	100
Tranche 02	27.78	80
Tranche 03	0	0
3. Level of thematic integration of science and technology with ATL		
Very effective	50	60
Moderate effective	44.44	40
Not effective	5.56	0
4. Degree of understanding of specified concepts compliance with ATL		
Very effective	61.11	60
Moderate effective	33.33	40
Not effective	5.56	0
5. MOU with other academic partnership		
Having MOU sign	16.67	60
6. Influence of ATL on students' negative towards higher education		
Very effective	66.67	80
Moderate effective	27.77	20
Not effective	5.56	0
7. Status of academic leadership influencing ATL implementation		
Excellent	27.78	20
Good	66.66	80
Average	5.56	0

Table 4.6: Functioning of ATL in Secondary Schools of Western Region on the basis of Nature of Management (Government and Private) (Govt. (N) = 18; Private (N) = 5)

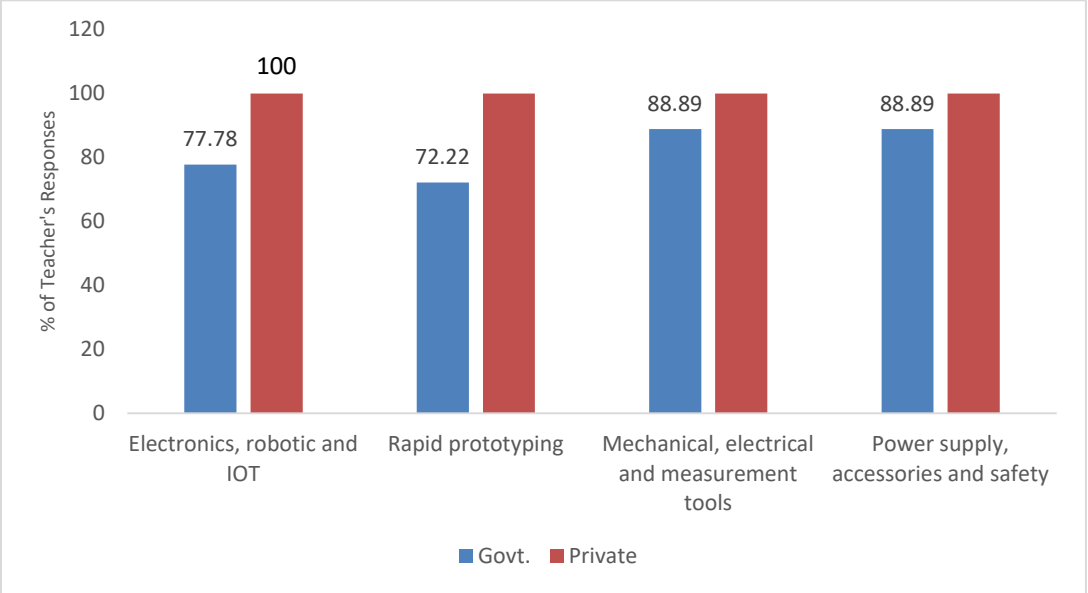


Figure 4.29: Available functional infrastructure

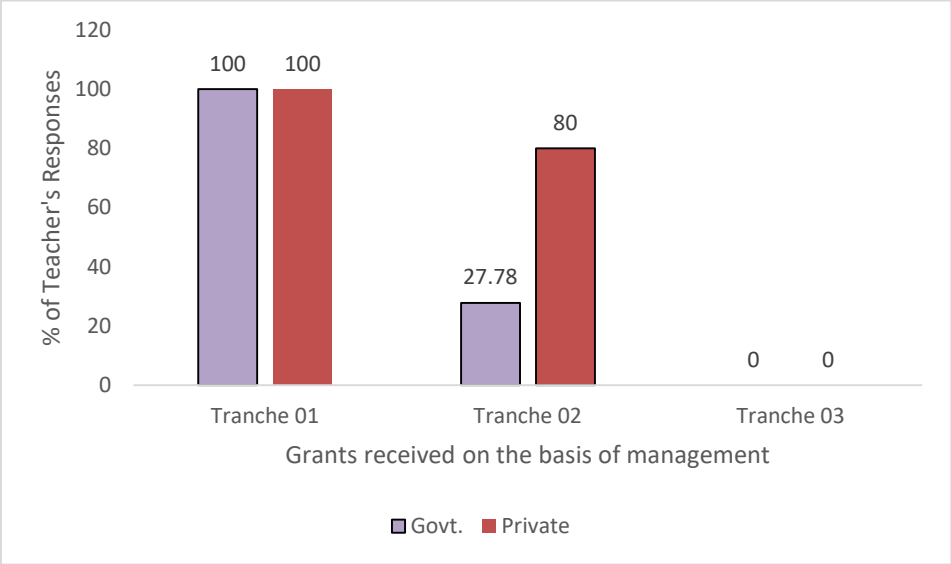


Figure 4.30: Level of grant received

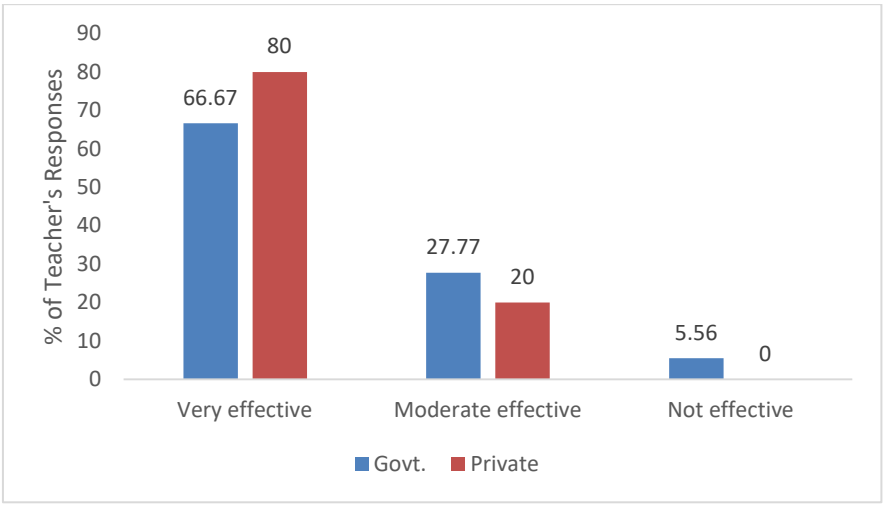


Figure 4.31: Level of thematic integration of science and technology with ATL

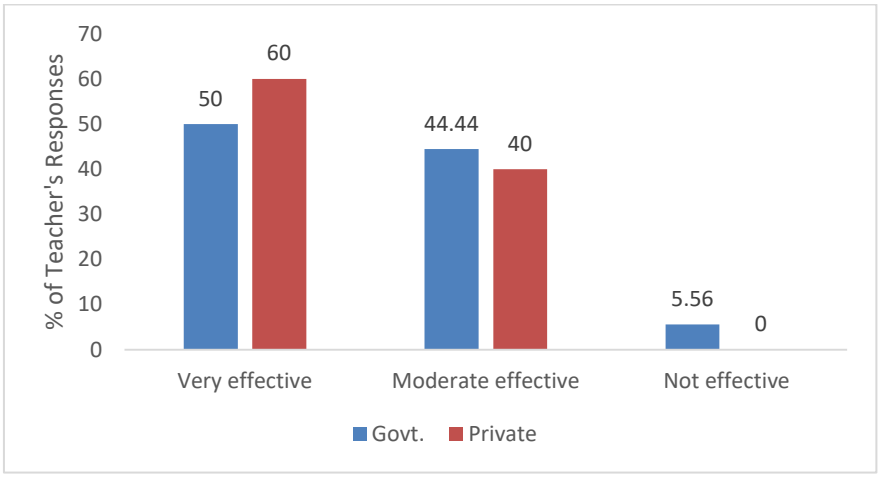


Figure 4.32: Degree of understanding of specified concepts compliance with ATL

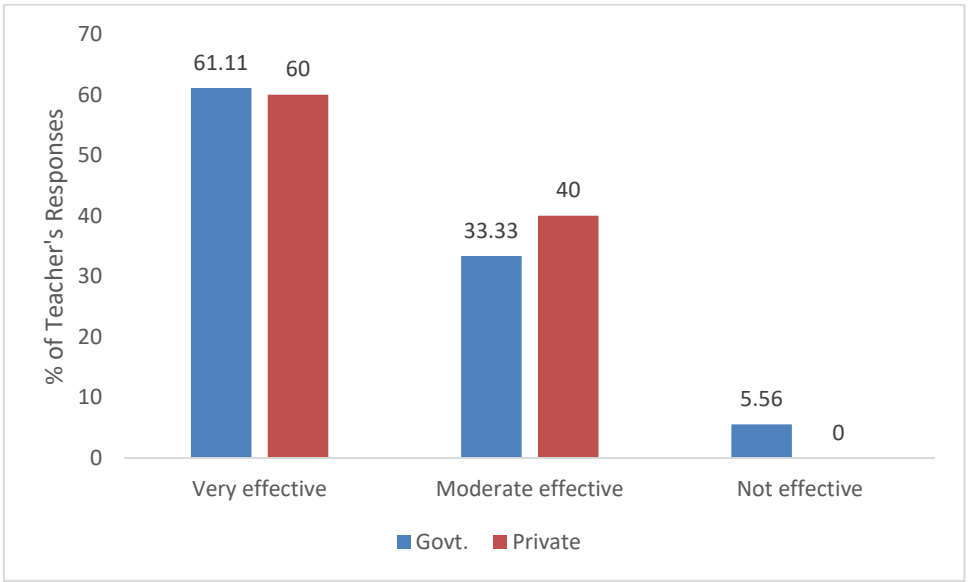


Figure 4.33: Influence of ATL on students' attitude towards higher education

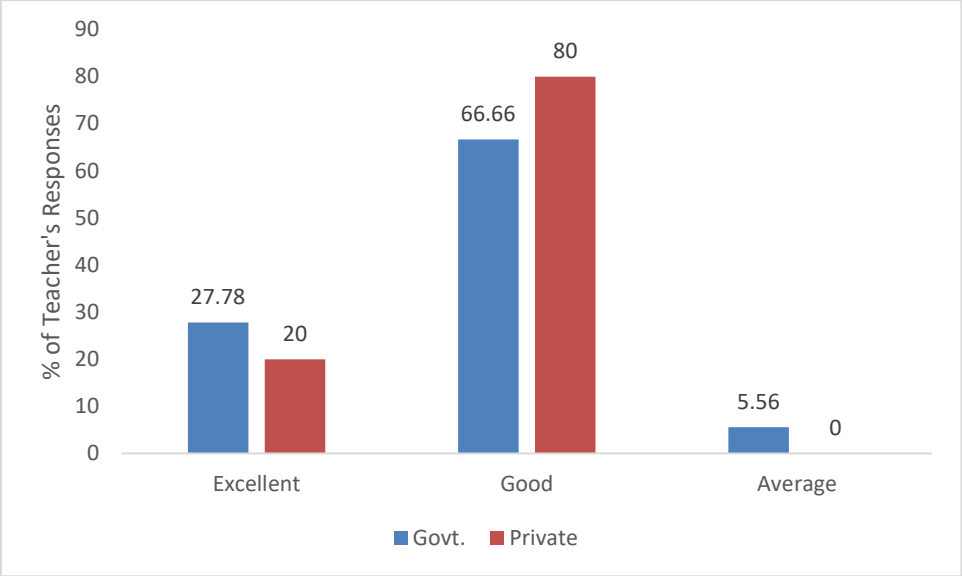


Figure 4.34: Status of academic leadership influencing ATL implementation

DISCUSSION

Based on the results presented in Table 4.3 it was found that most of the ATL in-charges report a high availability of essential tools and equipment in schools. Specifically, 86.95% reported the availability of electronics, robotic and IoT, and 91.30% for mechanical, electrical and measurement tools. This infrastructure supports the integration of STEM concepts, with 52.17% ATL in-charges reporting that they could integrate the concepts of science and technology from the curriculum very effectively. Furthermore, 60.86% find it very effectively done regarding the understanding of specified concepts through ATL activities, indicating a positive correlation between available resources and effective learning outcomes. However, it is noteworthy that only 26.08% ATL in-charges reported that the school has MOU with other institutions, suggesting potential areas for improvement in collaboration and resource sharing.

It was found that student engagement in ATL programs is structured yet flexible, with participation levels varying by interest and exposure (Table 4.4). Most of the schools have organized Workshop and seminars Online Achievement Day, indicating high engagement in these activities. However, a moderate level of participation was seen in visits undertaken by students to industries, innovations registered with AIM, and low participation was observed in programs like AIM Hackathon, ATL Tinkerpreneur, Intellectual Property Rights granted and under process. This data suggests that while some ATL activities are popular, others struggle to attract significant student involvement.In this section a discussion of the results pertaining to teachers' perspective on the usage of ATL in rural and urban schools along with participation of students in different

ATL activities is given. From the results presented it was found that a significant percentage of teachers reporting functional electronic, robotic, and IoT tools in their laboratories. Specifically, 85.71% and 81.25% respectively have reported that electronic, robotic and IoT are functional in the laboratories in their respective school. Furthermore, all schools have received the Tranche 1 grant, and while a majority of urban schools have received the Tranche 2 grant (85.71%), rural schools lag behind at only 18.75%. This suggests that while ATL is functioning, there are notable differences in resource availability and support between urban and rural settings.

The integration of ATL activities with the curriculum is perceived differently in urban and rural areas. In urban areas, 42.85% ATL in-charges reported that they could integrate the concepts of science and technology from the curriculum with ATL activities in a very effective manner as compared to 56.25% in rural areas. Moreover 57.14% reported the integration was moderately effective in urban areas, while only 37.5% of rural respondents felt the same. This indicates that while integration is occurring, rural areas may have a higher perception of effectiveness in this regard.It was also found that ATL has a positive influence on students' career prospects, particularly in urban schools 85.71% for urban areas and 56.25% for rural areas find it effective in shaping better educational and vocational outcomes.Additionally, 14.29% for urban areas and 31.25% find it moderately effective, indicating that while many see the benefits, there is a notable portion of rural respondents who do not perceive the same level of effectiveness. This disparity highlights the varying impacts of ATL on students' career choices and opportunities based on geographic location.

With regards to government and private schools the perspective of ATL in-charges indicates a more favorable view of ATL in private schools compared to government schools. For instance, 60% ATL in-charges in private schools reported that they could integrate the concepts of science and technology from the curriculum with ATL activities in a very effective manner, while only 50% for government schools reported the same level of effectiveness. Additionally, when assessing the degree of understanding of specified concepts related to ATL, 60% in private schools find very effective compliance and for government schools it was 56.25%."

Moreover, the influence of ATL on students' prospects is perceived more positively in private schools, with 80% for private schools finding it effective, compared to 66.67% for government schools. This suggests that ATL in-charges in private schools see a stronger impact of ATL on educational outcomes than their counterparts in government schools. It was found in an assessment of ATL by Athena Infonomics that private schools have been able to gather more funds as compared to government schools for purchasing of additional resources of ATL. This may be having an indirect effect on the performance of government schools with regards to ATL.

4.3 RESULTS OF OBJECTIVE - 2

Objective 2: Effectiveness of ATL in achievement of Learning Outcomes of Secondary School students of Western Region

INTRODUCTION

The Atal Tinkering Lab (ATL) Curriculum is a structured program developed by the Atal Innovation Mission to foster creativity, innovation, and problem-solving skills among students. It emphasizes hands-on learning in Science, Technology, Engineering, and Mathematics (STEM) through a variety of modules and resources. It aims to promote hands-on learning and empower students people to build the skills and attributes required for success in the 21st century. The curriculum focuses on a wide variety of concepts, ranging from basic electronics, mechanics, data visualization, and woodworking, to more advanced technologies such as 3D printing, the Internet of Things, and design thinking. Through hands-on, experiential learning, students will be encouraged to identify and design creative solutions to everyday problems.

CURRICULUM OBJECTIVES

(As given in AIM website)

Students will be able to:

● Turn ideas into reality by brainstorming, modelling and prototyping.

● Inculcate innovative and entrepreneurial mind-set through Design thinking and Hands-on Learning.

● Identify and research problems in their community and beyond, generate relevant and creative solutions, and develop sustainability plans for their solutions.

● Identify and self-learn for dignified career opportunities based on their skills and interests, particularly in STEM or entrepreneurship.

● Develop basic knowledge in electrical and mechanical engineering principles.

● Develop skills of using hand tools to construct a prototype of an engineering design.

CURRICULUM STRUCTURE

The ATL Curriculum engages students actively in the development of hands-on activities through a sequence of 3 Levels with incremental difficulty. Each level comprises of different modules, which are further subdivided into sessions. It is highly recommended to start the course with Level 1 and end the course with Level 3. The details of each level is as follows:

- Level 1 comprises of 5 modules namely, Basic Electronics, Mechanics, 3D Design & Printing, Data Visualisation and Design & Entrepreneurial Thinking.
- Level 2 comprises of 4 modules namely, Electronics, Mechanics, 3D Design & Printing and Design & Entrepreneurial Thinking.
- Level 3 comprises of 5 modules namely, Electronics, IoT, 3D Design & Printing, Wood Working and Design & Entrepreneurial Thinking.

The achievement test comprised of questions from all the three levels and were categorized under knowledge, understanding and application questions. The questions were included from the following areas-

- Data Interpretation

- 3D Designing and Printing

- Entrepreneurial Thinking

- Electrical and Electronics

- Internet of Things (IoT)

- Mechanics

Based on the above curriculum and objectives a standardized achievement test was prepared to assess the performance of students by a team of experts. Hence the reliability of the test was established. A pilot test was done and test re-test method was used to check the validity of the test. Item wise difficulty level of the questions was also checked. The test was then administered on a total of 618 students of different states of Western Region. The achievement test is given in

Annexure B **(Tool no. 2)**i.e; AssessingtheEffectivenessofAtalTinkeringLabs(ATLs)onLearningOutcomesinPromoting21st CenturySkillsforSecondaryStudents.

RESULTS

The results of the test are presented in Table 4.7. The total number of questions in the test was 52. Scores of the students have been divided into High (for more than 27 marks obtained), moderate (in the range 13-27 marks) and low (less than 13 marks). The percentage of students scoring high (above 27) is relatively low (17.31%), showing that a limited proportion excels academically. As can be seen from Table 4.7, 69% students have achieved moderate scores in the test. 13.27% of students are in the low-achievement category, reflecting potential challenges in adapting to the ATL-based learning process. Figure 4.35 shows the overall level -wise Performance for academic achievement assessment of Secondary Schools Students of Western Region.

Sl. No.	**Level of Scores**	**Range**	**No. of Students**	**% of Students**
1.	High	More than 27	107	17.31%
2.	Moderate	13- 27	429	69.42%
3.	Low	Less than 13	82	13.27%
	Total		618	100.00%

Table 4.7: Academic Achievement Assessment (Overall)

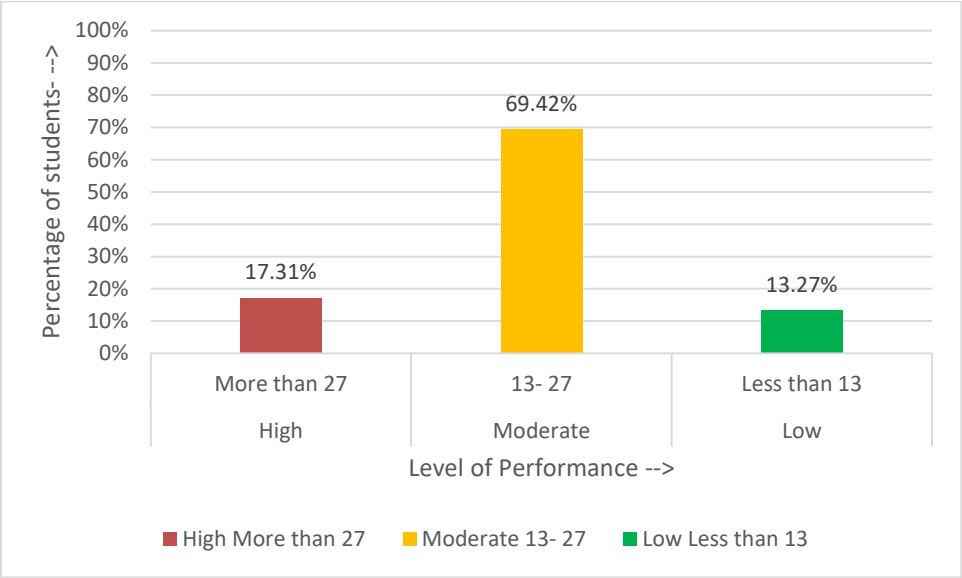


Figure 4.35: Overall Level -wise Performance for Academic Achievement Assessment among Secondary Schools Students of Western Region (Data Source: Table 4.7)

The academic achievement assessment was also done on the basis of locality for urban and rural schools of Western Region. Results pertaining to this are presented in table 4.8 and figure 4.36. Again it was found that both urban and rural school students achieved moderate scores in the test. Rural students (21.34%) outperform urban students (15.86%) in high achievement, suggesting that ATL has a stronger academic impact in rural settings. However, moderate scores dominate both urban (71.15%) and rural (64.63%) categories, implying a need for targeted interventions to push more students toward high achievement. Low achievement is slightly higher among urban students (13.00%) compared to rural students (14.02%), reinforcing a general parity across both localities.

Sl. No.	Level of Scores	Range	Locality	No. of Students	% of Students
1.	High	More than 27	Urban	72	15.86%
			Rural	35	21.34%
2.	Moderate	13- 27	Urban	323	71.15%
			Rural	106	64.63%
3.	Low	Less than 13	Urban	59	13.00%
			Rural	23	14.02%

Table 4.8: Academic Achievement Assessment on the Basis of Locality

(Urban (N)= 454, Rural (N)= 164)

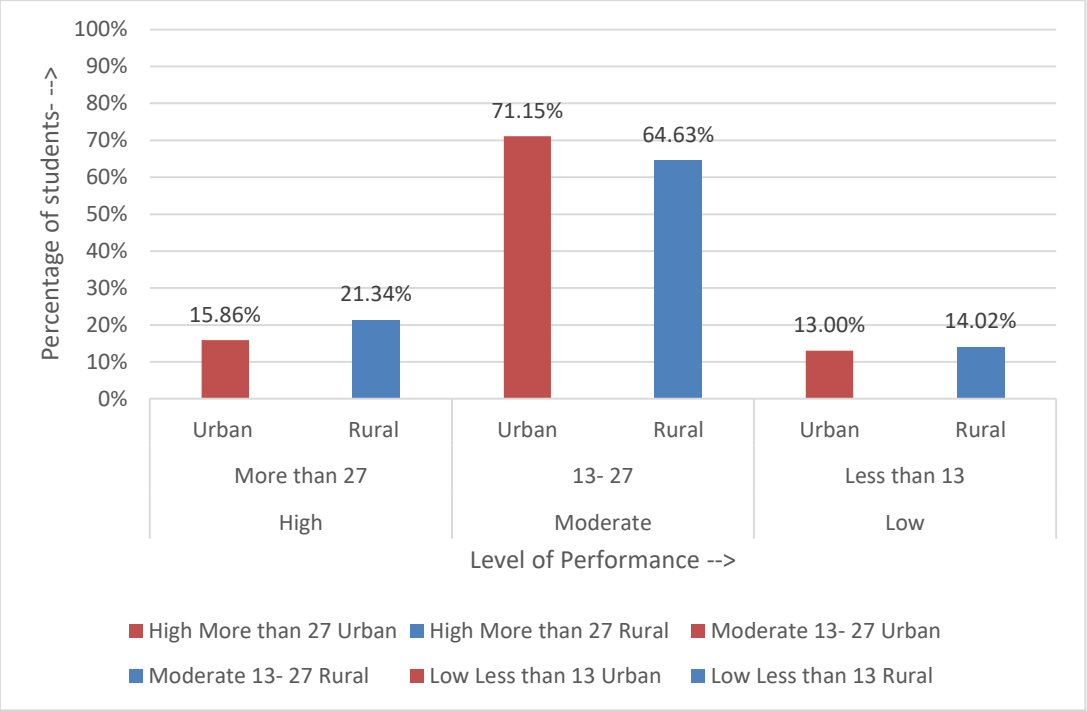


Figure 4.36: Overall Level -wise Performance for Academic Achievement Assessment among Secondary Schools Students of Western Region on the Basis of Locality (Data Source: Table 02)

When comparing theacademic achievement for government and private schools it was found that achievement scores for government schools in the moderate level was highest (71.40%). For high level score again government school students are ahead of private schools. Results are shown in table 4.9 and figure 4.37. Government school students (17.80%) outperform private school students (14.44%) in high achievement, showing ATL's effectiveness in the public education sector. However, private schools exhibit a significantly higher percentage of students in the low-achievement category (27.78%) compared to government schools (10.80%), warranting further analysis of ATL implementation in private institutions.

Sl.No.	Level of Scores	Range	Locality	No. of Students	% of Students
1.	High	More than 27	Government	94	17.80%
			Private	13	14.44%
2.	Moderate	13- 27	Government	377	71.40%
			Private	52	57.78%
3.	Low	Less than 13	Government	57	10.80%
			Private	25	27.78%

Table 4.9: Academic Achievement Assessment on the Basis of Nature of Management (Government (N)= 528, Private (N)= 90)

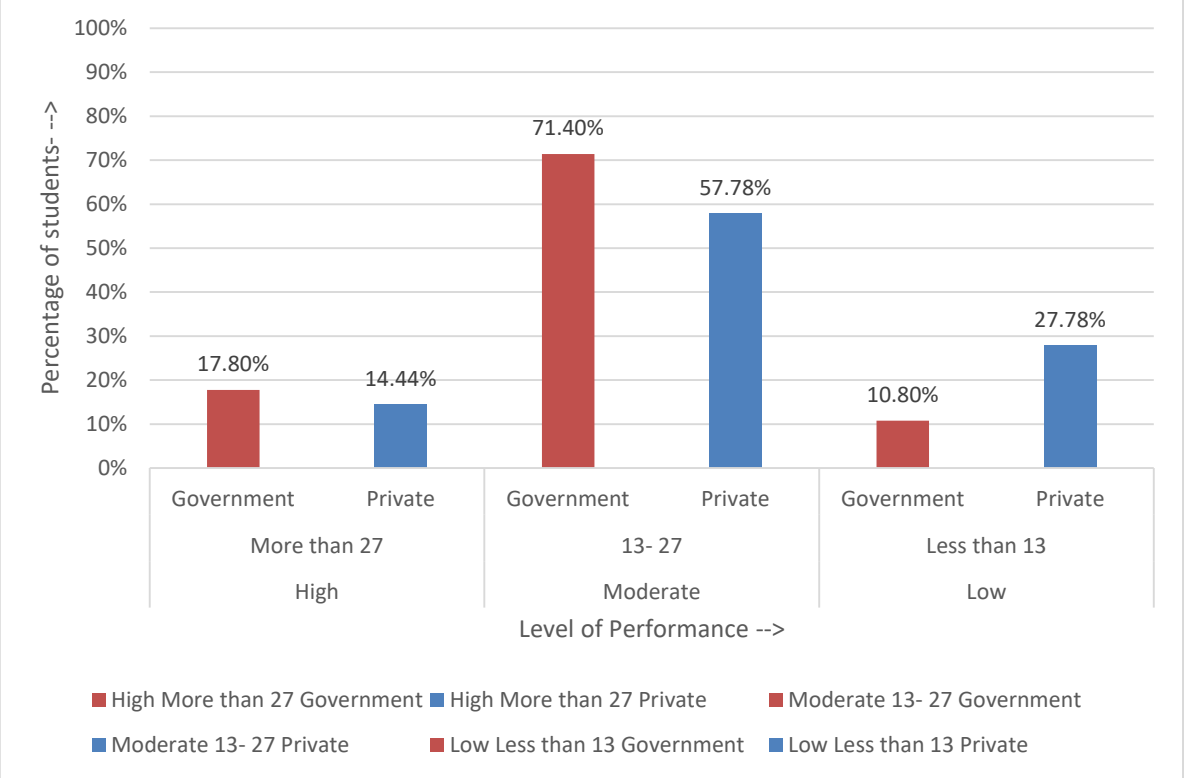


Figure 4.37: Overall Level -wise Performance for Academic Achievement Assessment among Secondary Schools Students of Western Region on the Basis of Nature of Management (Data Source: Table 4.9)

The academic achievement assessment statewise and classified on the basis of locality are presented in Table 4.10 and Figure 4.38. Out of all the states,32.65% students of rural areas of Chhatttisgarh are in the high level bracket of scores. And in the moderate level the highest percentage of students is that of Madhya Pradesh rural (80%). Maximum numbers of students of

Goa rural are in the low level bracket of scores (58.82%). Chhattisgarh and Maharashtra show the highest percentage of high-achievers in both urban and rural contexts, indicating strong ATL integration. Goa's rural sector has the highest low-achievement percentage (58.82%), highlighting a pressing need for targeted intervention. Madhya Pradesh and Gujarat exhibit moderate performance across both urban and rural sectors, with an inclination towards the moderate achievement category.

State	Locality	Level of Scores					
		High		Moderate		Low	
		No. of students	% of students	No. of students	% of students	No. of students	% of students
Chhattisgarh	Urban (40)	11	27.50%	28	70.00%	1	2.50%
	Rural (98)	32	32.65%	62	63.27%	4	4.08%
Goa	Urban (41)	10	24.39%	29	70.73%	2	4.88%
	Rural (17)	1	5.88%	6	35.29%	10	58.82%
Gujarat	Urban (112)	13	11.61%	78	69.64%	21	18.75%
	Rural (29)	0	0.00%	22	75.86%	7	24.14%
Madhya Pradesh	Urban (152)	17	11.18%	111	73.03%	24	15.79%
	Rural (20)	2	10.00%	16	80.00%	2	10.00%
Maharashtra	Urban (109)	21	19.27%	77	70.64%	11	10.09%
	Rural (0)	NA	NA	NA	NA	NA	NA

Table 4.10: Academic Achievement Assessment on the Basis of State-wise Locality(Urban – Rural)

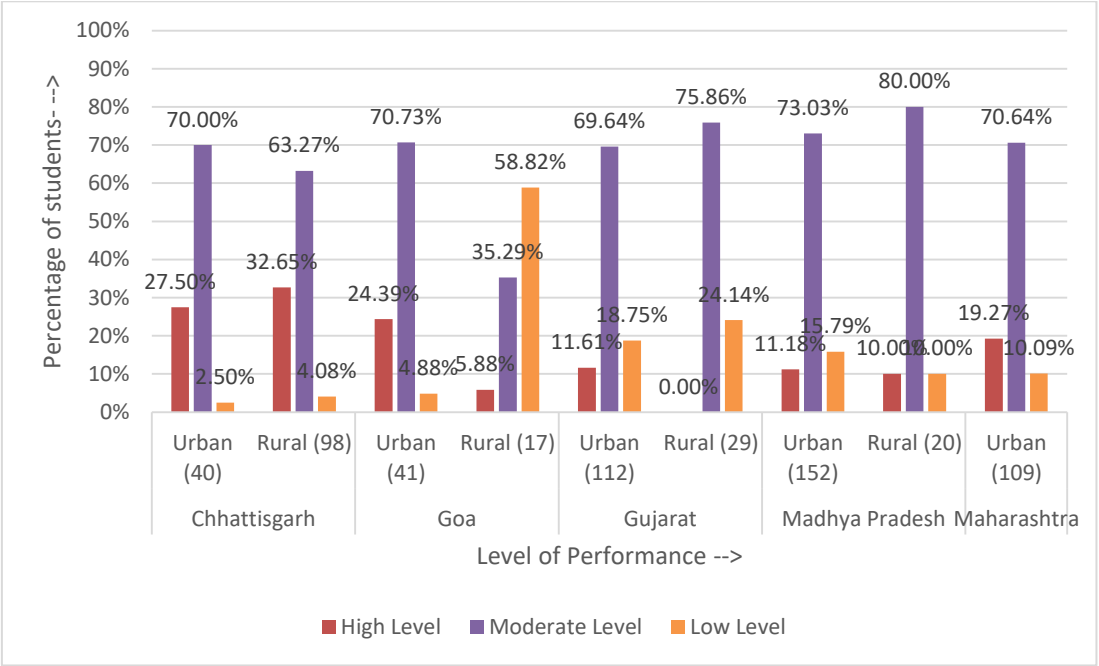


Figure 4.38: Overall Level -wise Performance for Academic Achievement Assessment among Secondary Schools Students of Western Region on the Basis of Locality State wise (Data Source: Table 04)

The performance of students of government and private schools has been studied and results are presented in Table 4.11 and in figure 4.39. On the basis of nature of management state wise it has been found that government school students are performing better than private school students with most of the students achieving scores in the moderate level bracket. In the high level bracket maximum number of students is from government schools of Chhattisgarh. Government schools in Chhattisgarh have the highest percentage of high-achievers (31.16%), whereas Gujarat's private schools show the weakest performance (3.77%). The high percentage of low-achievers in Gujarat's private institutions (26.42%) suggests discrepancies in implementation between government and private settings.

State	Nature of Management	Level of Scores					
		High		Moderate		Low	
		No. of students	% of students	No. of students	% of students	No. of students	% of students
Chhattisgarh	Government (138)	43	31.16%	90	65.22%	5	3.62%
	Private (0)	NA	NA	NA	NA	NA	NA
Goa	Government (21)	0	0.00%	20	95.24%	1	4.76%
	Private (37)	11	29.73%	15	40.54%	11	29.73%
Gujarat	Government (88)	11	12.50%	63	71.59%	14	15.91%
	Private (53)	2	3.77%	37	69.81%	14	26.42%
Madhya Pradesh	Government (172)	19	11.05%	127	73.84%	26	15.12%
	Private (0)	NA	NA	NA	NA	NA	NA
Maharashtra	Government (109)	21	19.27%	77	70.64%	11	10.09%
	Private (0)	NA	NA	NA	NA	NA	NA

Table 4.11: Academic Achievement Assessment on the Basis of Nature of Management (Government – Private)

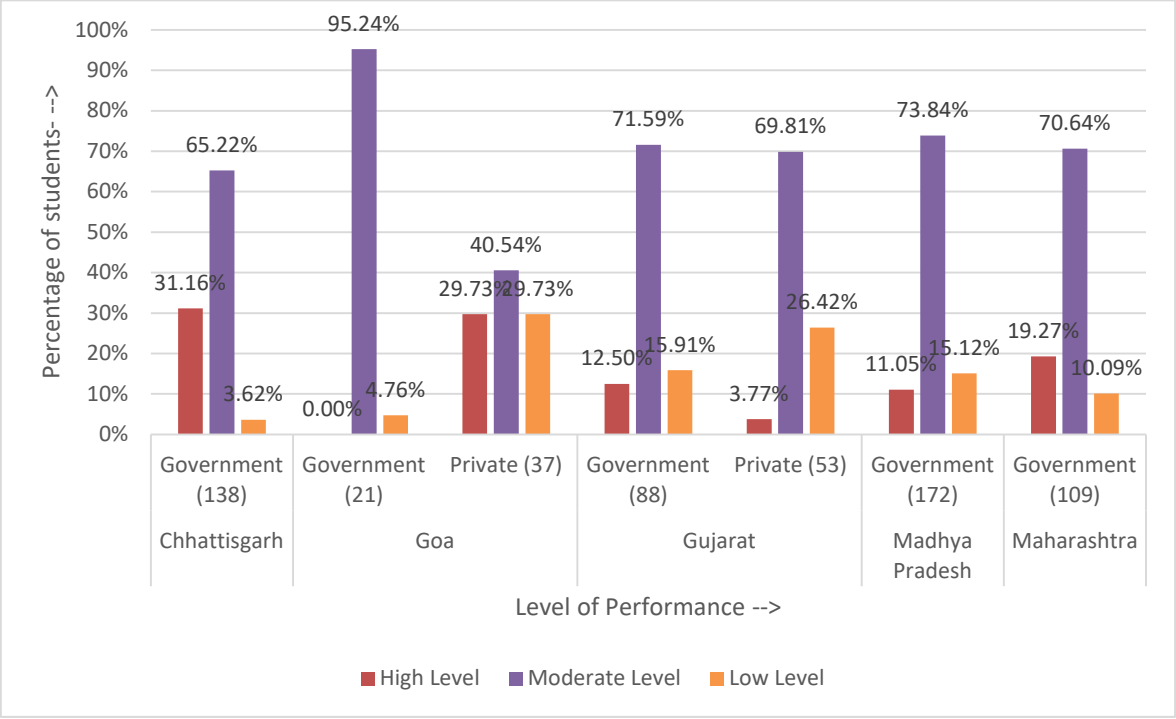


Figure 4.39: Overall Level -wise Performance for Academic Achievement Assessment among Secondary Schools Students of Western Region on the Basis of Nature of Management State wise (Data Source: Table 05)

DISCUSSION

In this chapter an analysis of academic achievement among secondary school students in the Western Region, focusing on the distribution of scores based on the ATL curriculum is presented. Student performance is categorized into three levels: high, moderate, and low. The findings indicate that only a small percentage of students (17.31%) achieve high scores, while the majority (69%) fall into the moderate category, and a smaller group (13.27%) scores low. Additionally, the assessment compares the performance of urban and rural school students, revealing that rural students have a slightly higher percentage of high achievers compared to their urban counterparts. However, moderate scores are prevalent in both groups, highlighting the need for interventions to enhance academic performance.

The differences in academic achievement based on locality, stating has also been analyzed. It was found that rural students (21.34%) outperform urban students (15.86%) in high achievement, suggesting that ATL has a stronger academic impact in rural settings. However, it was also found that moderate scores dominate both urban (71.15%) and rural (64.63%) categories, indicating the need for interventions to improve high achievement levels. Low achievement is slightly higher among urban students (13.00%) compared to rural students (14.02%), reinforcing a general parity across both localities. From the results it has been found that rural schools and government institutions benefit more from ATL integration. Private schools and specific rural areas (e.g., Goa) may need tailored interventions. A need for customized pedagogical support for low-performing private schools, enhanced mentor support, and a review of ATL's impact on Goa's rural education

system. The data reveals a tri-modal distribution: **69.42%** of students scored in the Moderate range (13–27), while only **17.31%** achieved High scores (>27) and **13.27%** fell into the Low category (<13). This suggests that while ATL interventions may foster foundational academic competencies, they are less effective in cultivating advanced mastery. The skew toward Moderate performance could reflect standardized curricular alignment rather than differentiated learning strategies. The bar graph visually reinforces the dominance of Moderate scores, highlighting a systemic gap in elevating students to higher proficiency tiers. The absence of a "Very High" category in scoring limits granularity in assessing top performers.

Contrary to expectations, rural students outperformed urban peers in High scores (**21.34% vs. 15.86%**), though urban areas led in Moderate scores (**71.15% vs. 64.63%**). This paradox may stem from rural students' limited access to alternative enrichment programs, making ATL their primary avenue for academic engagement.

Government schools reported higher High scores (**17.80% vs. 14.44%**), while private schools had a larger Low cohort (**27.78% vs. 10.80%**). This challenges assumptions about private sector efficacy, possibly due to ATL's equitable resource distribution in government institutions. The clustered bars for locality and management reveal stark contrasts. For instance, Maharashtra's rural data is omitted (N=0), undermining comparative analysis. Graphs would benefit from error margins or confidence intervals to assess statistical significance.

Chhattisgarh's rural students excelled (**32.65% High**), while Goa's rural cohort struggled (**58.82% Low**), indicating regional disparities in ATL implementation. Gujarat's urban Low scores (**18.75%**) suggest infrastructural or pedagogical challenges. Maharashtra's government schools achieved **19.27% High scores**, outperforming other states. Private schools in Goa and Gujarat, however, lagged significantly (**29.73% Low in Goa Private**), signaling systemic inequities. State-wise graphs (e.g., Figure 04) use inconsistent scaling, exaggerating minor differences (e.g., Chhattisgarh's 2.5% urban Low vs. 4.08% rural Low). A normalized scale would enhance comparability. ATL's focus on broad-based competency (Moderate scores) risks neglecting high-potential learners. Differentiated instruction and advanced modules are needed. Rural outperformance in High scores warrants deeper study—possibly linked to community-driven motivation or fewer distractions.

4.4 RESULTS OF OBJECTIVE-3

Objective 3 - Study the Effectiveness of ATL in Promoting Key 21st Century Skills, viz, Design Thinking, Entrepreneurship and innovation among Secondary Students of Western Region

DESIGN THINKING SKILLASSESSMENT

INTRODUCTION

Atal Tinkering Labs (ATLs), under the **Atal Innovation Mission (AIM)**, provide a dynamic environment for students to develop **design thinking, entrepreneurship, and innovation skills**. These labs serve as incubators for **hands-on learning, problem-solving, and entrepreneurial exploration**, preparing students for 21st-century challenges. Design thinking is a **human-centered, iterative process** for solving problems. In **Atal Tinkering Labs (ATLs)**, students engage in **hands-on learning** using tools like robotics, 3D printing, IoT, and AI, making ATL an

ideal space for applying Design Thinking principles. Design Thinking equips individuals with the ability to solve real-world problems through innovative solutions. Think creatively and generate multiple ideas. It also helps to develop empathy by understanding users' needs.It also gives a chance to students to collaborate effectively in teams. Design thinking encourages project-based learning and experiential education and helps students develop problem-solving and collaboration skills. The ATL curriculum effectively integrates design thinking by guiding students through problem identification, ideation, prototyping, and testing**.** By engaging in hands-on,user-centric innovation**,** students develop 21st-century skills like creativity, resilience, and an entrepreneurial mindset. The Atal Tinkering Lab (ATL) curriculum is designed to foster innovation, problem-solving, and entrepreneurial thinking among students. By engaging in hands-on learning, prototyping, and business model development, ATL equips students with the necessary skills to become future entrepreneurs and job creators. With exposure to technology, innovation, and industry mentorship, ATL nurtures the next generation of startup founders and changemakers.

In this chapter the key 21st Century Skills, viz, Design Thinking and Entrepreneurship among Secondary Students of Western Region have been studied using data collected from 618 students. The **Tool 3** used for this study is given in Annexure C, i.e; Effectiveness of ATL in Promoting Key 21st Century Skills, viz, Design Thinking, Entrepreneurship and innovation among Secondary Students of Western Region . The tool was made by a team of experts in the field.

RESULTS

The results of assessment of design thinking skill of secondary students using the ATL lab has been presented in Table 4.12. The design thinking tool questions were designed on a five point scale. Scores of all students from different states were used in the study. It can be seen from Table 4.12 that more than half of the students (66.67%) fall in the bracket of low scores. 31.23% students scored in the moderate level bracket. And a very few percentage of students are in the high level bracket (2.10%). A significant portion (66.67%) of students falls in the low skill category, highlighting a crucial gap in fostering design thinking competencies. Only 2.10% of students score high, showing that design thinking is not yet a well-developed skill within the ATL ecosystem. Figure 4.40 shows the overall level -wise performance for Design Thinking Assessment among Secondary Schools Students of Western Region.

Sl. No.	Level of Scores	Range	No. of Students	% of Students
1.	High	4	13	2.10%
2.	Moderate	2 – 3	193	31.23%
3.	Low	0 – 1	412	66.67%
	Total		618	100.00%

Table 4.12: Design Thinking Assessment (Overall)

Figure 4.40: Overall Level -wise Performance for Design Thinking Assessment among Secondary Schools Students of Western Region (Data Source: Table 4.12)

The study of development of design thinking skill in secondary students was also studied on the basis of locality and results are presented in Table 4.13. Maximum number of students for both rural and urban areas score in the low-level bracket (69.38% for urban and 59.15% for rural) necessitating strategic interventions. Rural students (4.88%) outperform urban students (1.10%) in design thinking skills, suggesting ATL's more profound influence in rural areas. Figure 4.41 shows the overall level -wise performance for Design Thinking assessment among Secondary Schools students of western region on the basis of locality.

Sl. No.	Level of Scores	Range	Locality	No. of Students	% of Students
1.	High	4	Urban	5	1.10%
			Rural	8	4.88%
2.	Moderate	2 – 3	Urban	134	29.52%
			Rural	59	35.98%
3.	Low	0 – 1	Urban	315	69.38%
			Rural	97	59.15%

Table 4.13: Design Thinking Assessment on the Basis of Locality (Urban (N)= 454, Rural (N)= 164)

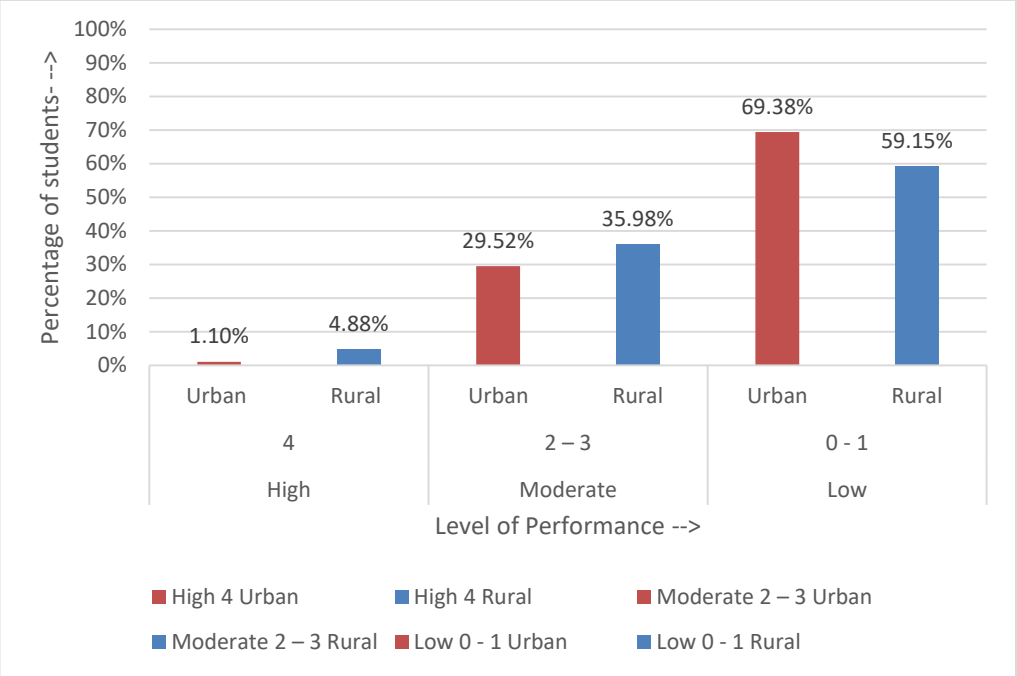


Figure 4.41: Overall Level -wise Performance for Design Thinking Assessment among Secondary Schools Students of Western Region on the Basis of Locality

The design thinking assessment on the basis of nature of managementis presented in Table 4.14. Results show that for both government and private schools the percentage of students in the low level score bracket is almost equal.Private school students (3.33%) slightly outperform government school students (1.89%) in high design thinking skills, indicating a marginally better approach in private institutions. However, both categories show a high percentage in the low-skill range (government: 66.86%, private: 65.56%), reinforcing a systemic weakness in ATL's design thinking pedagogy. Figure 4.42 shows overall level -wise performance for Design Thinking assessment among secondary schools' students of Western Region on the basis of the nature of management.

Sl. No.	Level of Scores	Range	Locality	No. of Students	% of Students
1.	High	4	Government	10	1.89%
			Private	3	3.33%
2.	Moderate	2 – 3	Government	165	31.25%
			Private	28	31.11%
3.	Low	0 - 1	Government	353	66.86%

			Private	59	65.56%

Table 4.14: Design Thinking Assessment on the Basis of Nature of Management (Government (N)= 528, Private (N)= 90)

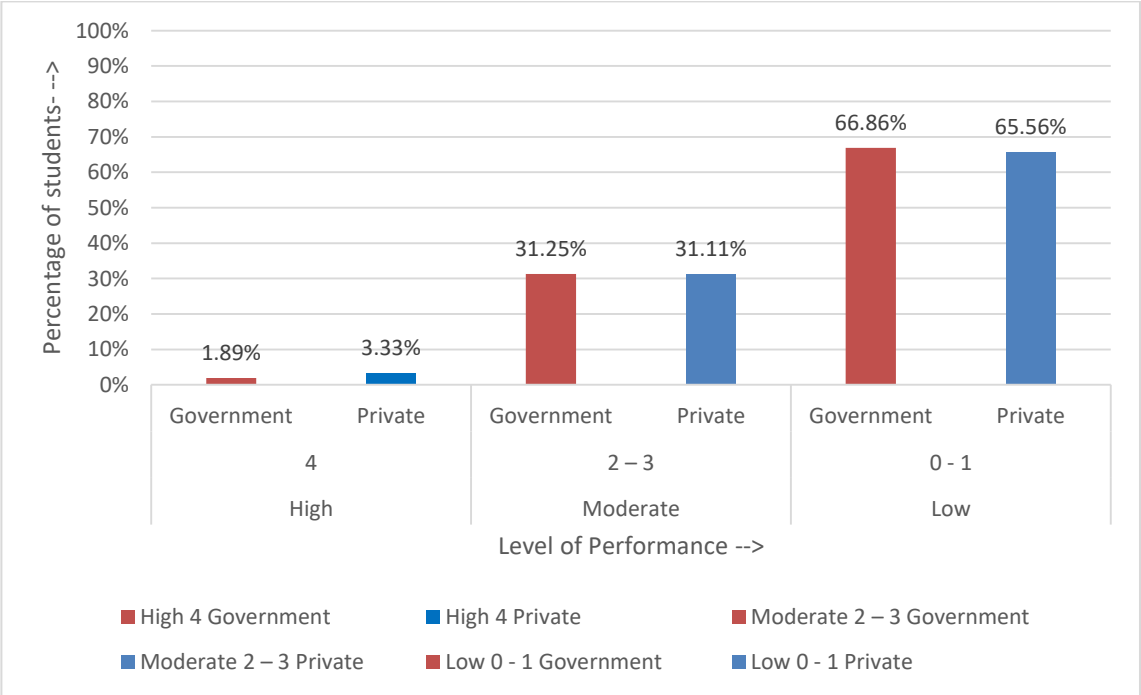


Figure 4.42: Overall Level -wise Performance for Design Thinking Assessment among Secondary Schools Students of Western Region on the Basis of the Nature of Management

The state wise design thinking assessment on the basis of locality is presented in Table 4.15. Gujarat's rural schools show an unusual pattern, with 13.79% of students demonstrating high design thinking skills, unlike other states. Madhya Pradesh urban schools have the highest percentage of low-skill students (75.66%), indicating significant challenges in integrating design thinking in urban government schools. Figure 4.43 shows the overall level -wise performance for Design Thinking assessment among secondary schools' students of western region on the basis of locality state wise.

State	Locality	Level of Scores					
		High		Moderate		Low	
		No. of students	% of students	No. of students	% of students	No. of students	% of students
Chhattisgarh	Urban (40)	0	0.00%	19	47.50%	21	52.50%
	Rural (98)	4	4.08%	30	30.61%	64	65.31%
Goa	Urban (41)	3	7.32%	18	43.90%	20	48.78%
	Rural (17)	0	0.00%	5	29.41%	12	70.59%
Gujarat	Urban (112)	1	0.89%	40	35.71%	71	63.39%
	Rural (29)	4	13.79%	16	55.17%	9	31.03%
Madhya Pradesh	Urban (152)	0	0.00%	37	24.34%	115	75.66%

	Rural (20)	0	0.00%	8	40.00%	12	60.00%
Maharashtra	Urban (109)	1	0.92%	20	18.35%	88	80.73%
	Rural (0)	NA	NA	NA	NA	NA	NA

Table 4.15: Design Thinking Assessment on the Basis of State-wise Locality(Urban – Rural)

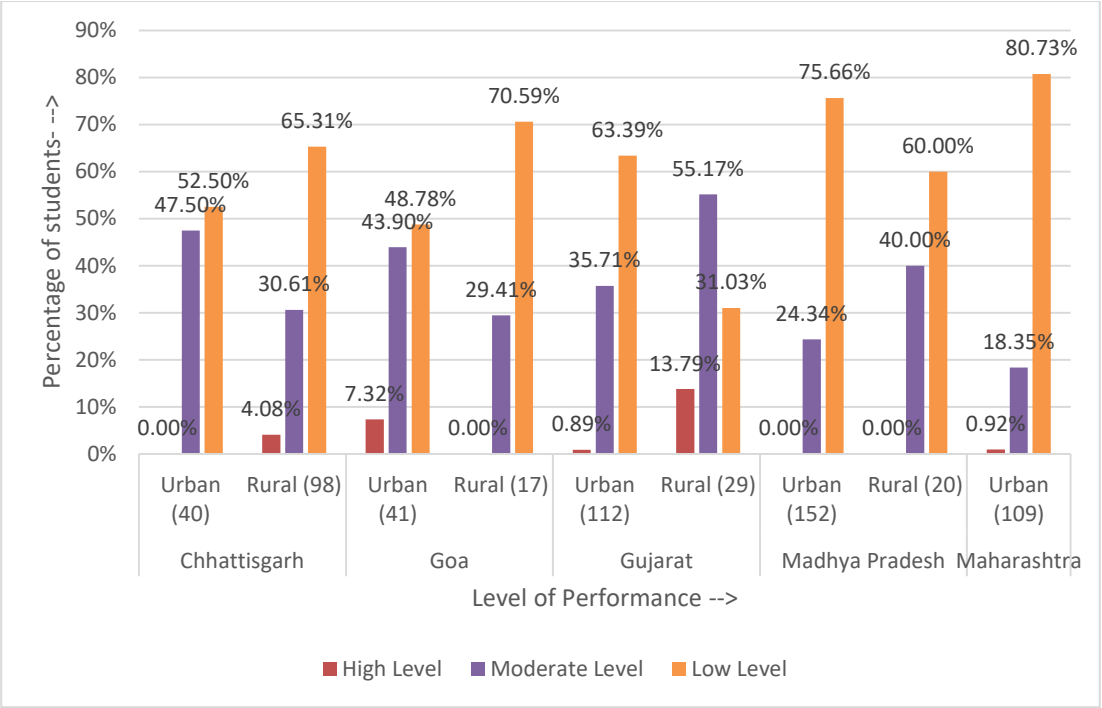


Figure 4.43: Overall Level -wise Performance for Design Thinking Assessment among Secondary Schools Students of Western Region on the Basis of Locality State wise

On the basis of management assessmentofDesign Thinking skill for all states included in the study is presented in Table 4.16. Maharashtra's government schools achieved 19.27% high scores, outperforming other states. Private schools in Goa and Gujarat, however, lagged significantly (29.73% Low in Goa Private), signaling systemic inequities.

State	**Nature of Management**	**Level of Scores**					
		High		**Moderate**		**Low**	
		No. of students	% of students	No. of students	% of students	No. of students	% of students
Chhattisgarh	Government (138)	4	2.90%	49	35.51%	85	61.59
	Private (0)	NA	NA	NA	NA	NA	NA
Goa	Government (21)	0	0.00%	4	19.05%	17	80.95
	Private (37)	3	8.11%	19	51.35%	15	40.54
Gujarat	Government (88)	5	5.68%	47	53.41%	36	40.91

	Private (53)	0	0.00%	9	16.98%	44	83.02
Madhya Pradesh	Government (172)	0	0.00%	45	26.16%	127	73.84
	Private (0)	NA	NA	NA	NA	NA	NA
Maharashtra	Government (109)	1	0.92%	20	18.35%	88	80.73
	Private (0)	NA	NA	NA	NA	NA	NA

Table 4.16: Design Thinking Assessment on the Basis of Nature of Management (Government – Private)

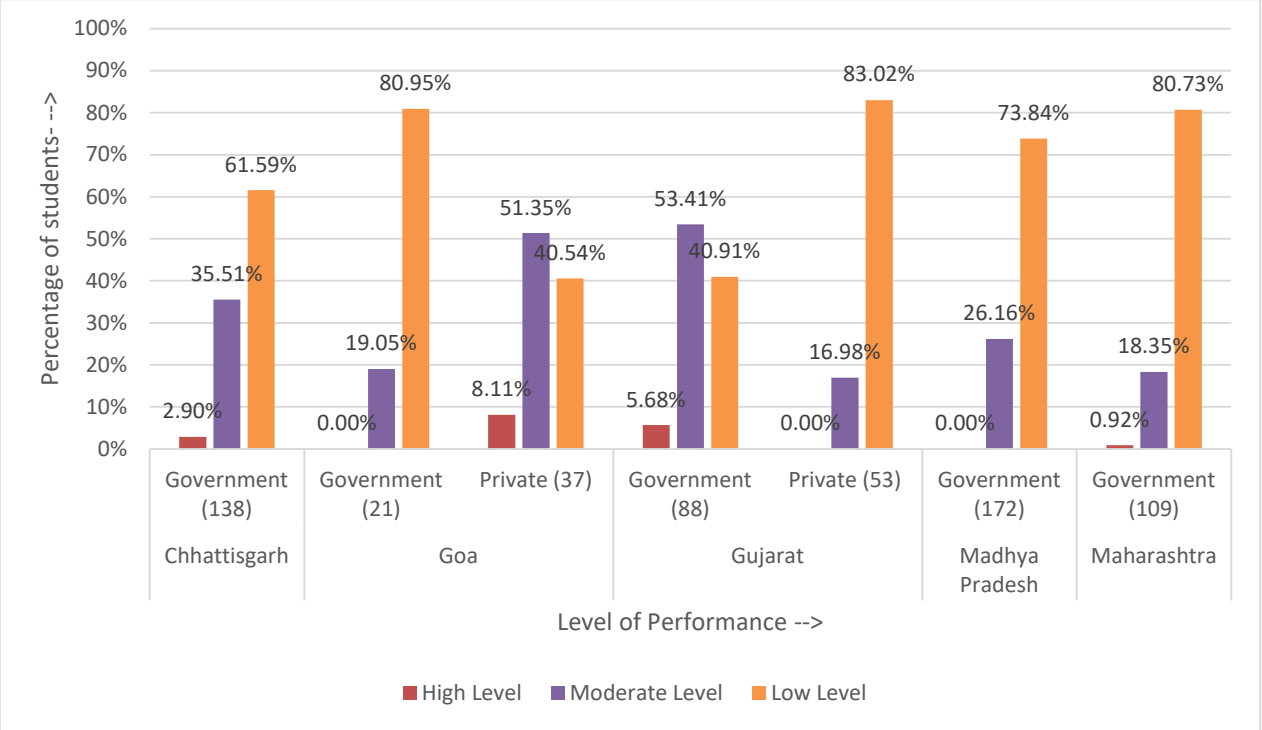


Figure 4.44: Overall Level -wise Performance for Design Thinking Assessment among Secondary Schools Students of Western Region on the Basis of Nature of Management State-wise

DISCUSSION

In this chapter the performance of students in design thinking assessments has been presented. The results reveal a concerning trend where the majority of students score in the low skill category. Specifically, 66.67% of students fall into this low score bracket, while only a small fraction (2.10%) achieves high scores. This indicates a critical deficit in creative design thinking skills, a

cornerstone of 21st-century education. The skew toward low performance suggests the projects made in ATL are not following the design thinking approach as desired.

The analysis is also segmented by locality, management type, and state, highlighting disparities in performance between urban and rural areas as well as between private and government schools. State-wise achievement shows variability, with notable differences in performance. For instance, Madhya Pradesh's urban schools have the highest percentage of low-skill students (75.66%), while "Maharashtra's government schools achieved 19.27% high scores, outperforming other states. Additionally, Gujarat's rural schools display a unique pattern with 13.79% of students demonstrating high design thinking skills, contrasting with performance in other states. Rural students marginally outperformed urban peers in High scores (4.88% vs. 1.10%), yet urban areas dominated Moderate scores (29.52% vs. 35.98%). This could reflect rural adaptability to resource constraints, fostering grassroots innovation. Gujarat's rural students achieved 13.79% high scores, the highest nationally, likely due to robust mentorship programs. Conversely, Maharashtra's urban cohort had 80.73% Low scores, signaling curricular misalignment.

Management-wise, the data indicates that private school students slightly outperform government school students in high design thinking skills, with private school students (3.33%) slightly outperforming government school students (1.89%). However, both types of schools exhibit a high percentage of low-skill students, with government schools at 66.86% and private schools at 65.56%, highlighting systemic weaknesses in the design thinking pedagogy across both management types.

Gujarat's rural success highlights the role of localized mentorship. Replicating such models in low-performing states (e.g., Maharashtra) is critical. The findings suggest a need for strategic interventions to improve design thinking competencies among students.

ENTREPRENEURSHIP SKILL ASSESSMENT

The results of assessment of design thinking skill of secondary students using the ATL lab has been presented in Table 4.17. The design thinking tool questions were designed on a five-point scale (Strongly Agree to Strongly Disagree). The scores assigned were 5 for Strongly Agree, 4 for Agree, 3 for Neither Agree or Disagree, 2 for Disagree and 1 for Strongly Disagree). Table 4.17shows the results ofEntrepreneurship Skills Assessment of students of all states.

A vast majority (87.22%) of students fall in the moderate category, implying a foundational understanding but a lack of advanced entrepreneurship skills. High-achieving students constitute only 4.21%, indicating a gap in pushing students towards higher entrepreneurial competencies.

Figure 4.45 shows the overall level -wise performance for Entrepreneurship Skill assessment among Secondary Schools Students of Western Region.

The assessment of Entrepreneurship Skills on also done on the basis of locality and results are presented in Table 4.18. Urban students (5.07%) have a higher percentage of high achievers compared to rural students (1.83%), reflecting the urban advantage in entrepreneurship exposure. However, rural students dominate the moderate category (94.51%), suggesting a strong foundational but underdeveloped entrepreneurial mindset. Figure 4.46 shows the overall level -wise performance for entrepreneurship Skill Assessment among secondary schools Students of Western Region on the basis of locality.

Sl. No.	Level of Scores	Range	No. of Students	% of Students
1.	High	More than 43	26	4.21%
2.	Moderate	22 – 43	539	87.22%
3.	Low	Less than 22	53	8.58%
	Total		618	100.00%

Table 4.17: Entrepreneurship Skills Assessment (Overall)

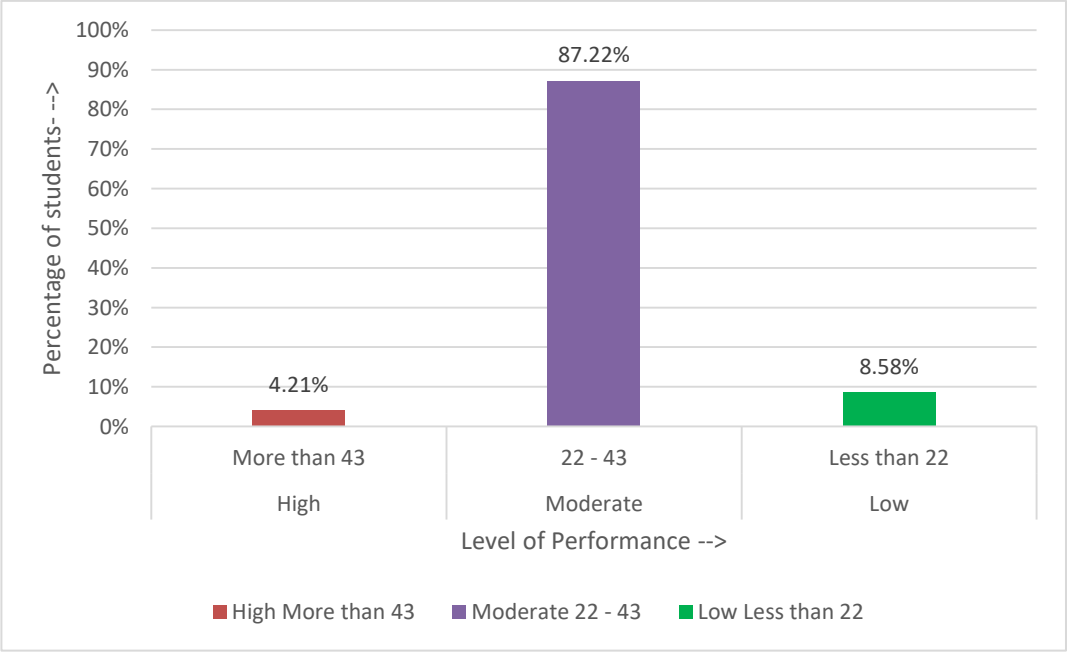


Figure 4.45: Overall Level -wise Performance for Entrepreneurship Skill Assessment among Secondary Schools Students of Western Region

Sl. No.	Level of Scores	Range	Locality	No. of Students	% of Students
1.	High	More than 43	Urban	23	5.07%
			Rural	3	1.83%
2.	Moderate	22 – 43	Urban	384	84.58%
			Rural	155	94.51%
3.	Low	Less than 22	Urban	47	10.35%
			Rural	6	3.66%

Table 4.18: Entrepreneurship Skills Assessment on the Basis of Locality (Urban (N)= 454, Rural (N)= 164)

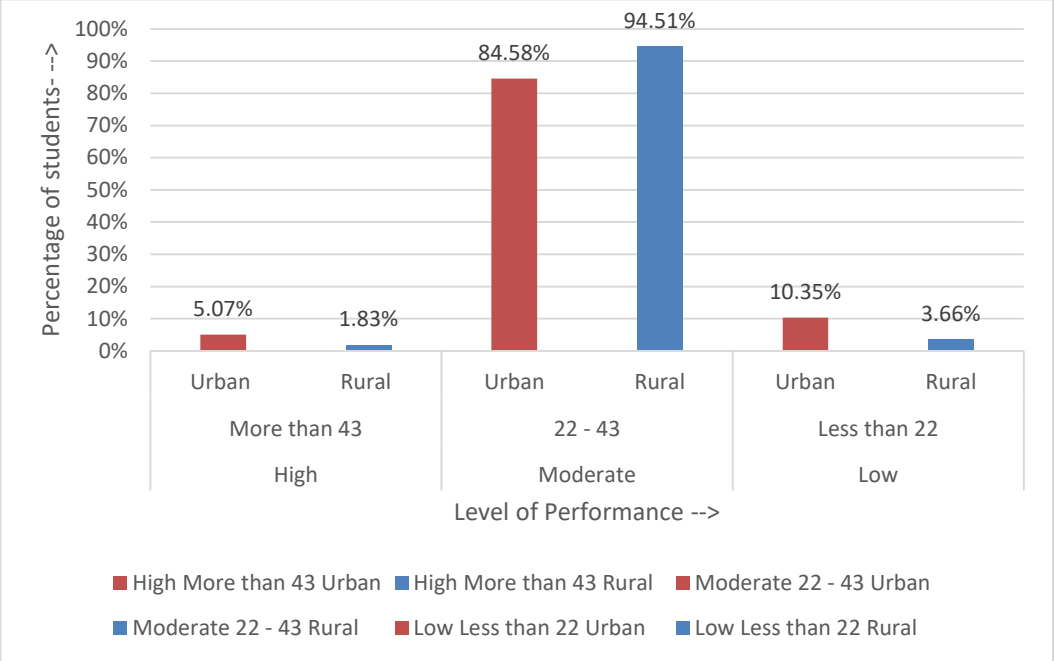


Figure 4.46: Overall Level -wise Performance for Entrepreneurship Skill Assessment among Secondary Schools Students of Western Region on the Basis of Locality (Data Source: Table 02)

The data was also classified on the basis of nature of management and results are presented in Table 4.19. Private school students (2.22%) have fewer high achievers than government schools (4.55%), but their moderate category percentage (94.44%) is higher, indicating more stable foundational learning. The low-achievement category is significantly higher in government schools (9.47%), indicating disparities in implementation. Figure 4.47 present the overall level - wise performance for entrepreneurship skill assessment among Secondary Schools Students of Western Region on the basis of nature of management.

Results of entrepreneurship skills assessment on the basis of state-wise locality are presented in Table 4.20. Gujarat's rural schools show a promising trend with 100% of students falling in the moderate category and none in the low category. Maharashtra's urban schools have the highest percentage of high achievers (11.93%), indicating an advanced entrepreneurial ecosystem. Chhattisgarh and Goa's government schools exhibit the highest percentage of low-achieving students, necessitating policy intervention.

Sl. No.	Level of Scores	Range	Locality	No. of Students	% of Students
1.	High	More than 43	Government	24	4.55%
			Private	2	2.22%
2.	Moderate	22 - 43	Government	454	85.98%
			Private	85	94.44%
3.	Low	Less than 22	Government	50	9.47%
			Private	3	3.33%

Table 4.19 Entrepreneurship Skills Assessment on the Basis of Nature of Management (Government (N)= 528, Private (N)= 90)

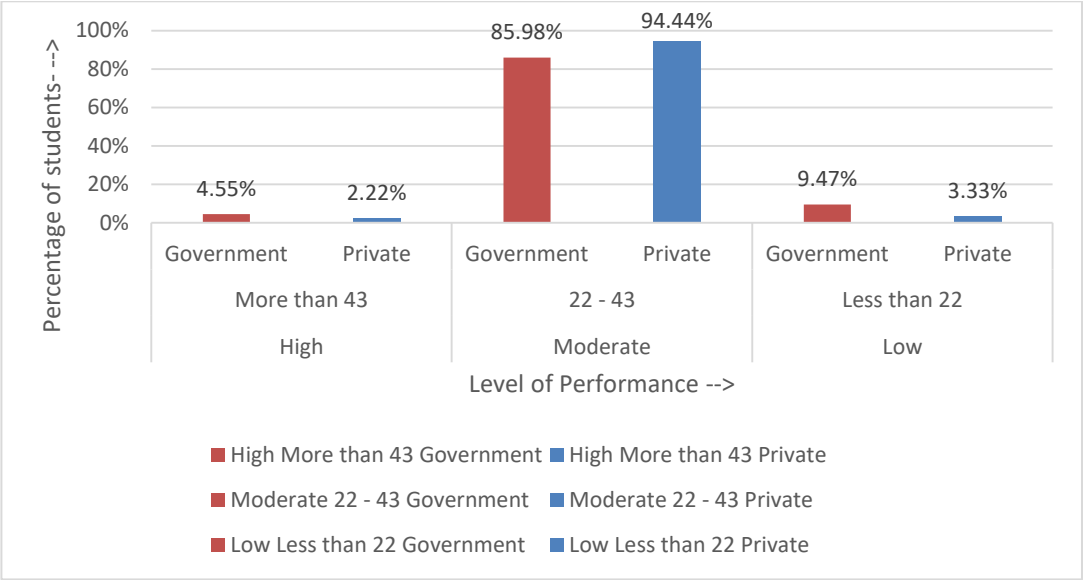


Figure 4.47: Overall Level -wise Performance for Entrepreneurship Skill Assessment among Secondary Schools Students of Western Region on the Basis of Nature of Management

State	Locality	Level of Scores					
		High		Moderate		Low	
		No. of students	% of students	No. of students	% of students	No. of students	% of students
Chhattisgarh	Urban (40)	1	2.50%	24	60.00%	15	37.50%
	Rural (98)	1	1.02%	94	95.92%	3	3.06%
Goa	Urban (41)	0	0.00%	36	87.80%	5	12.20%
	Rural (17)	0	0.00%	15	88.24%	2	11.76%
Gujarat	Urban (112)	4	3.57%	106	94.64%	2	1.79%
	Rural (29)	0	0.00%	29	100.00%	0	0.00%
Madhya Pradesh	Urban (152)	5	3.29%	128	84.21%	19	12.50%
	Rural (20)	2	10.00%	17	85.00%	1	5.00%
Maharashtra	Urban (109)	13	11.93%	90	82.57%	6	5.50%
	Rural (0)	NA	NA	NA	NA	NA	NA

Table 4.20: Entrepreneurship Skills Assessment on the Basis of State-wise Locality (Urban – Rural)

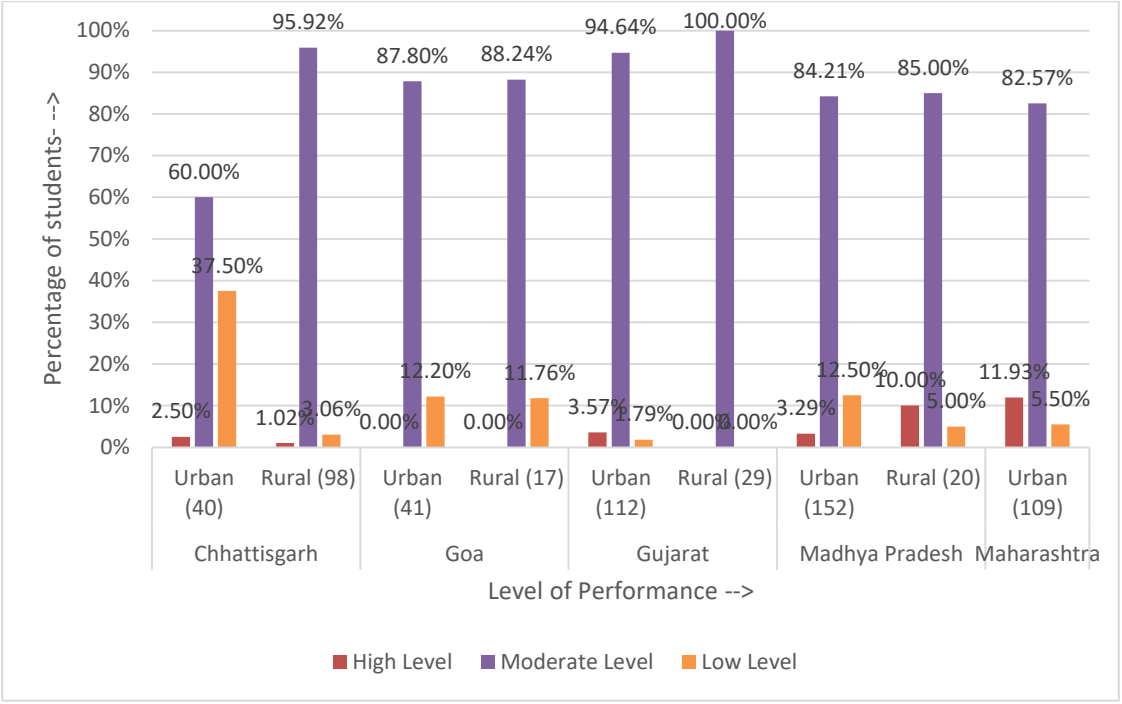


Figure 4.48: Overall Level -wise Performance for Entrepreneurship Skill Assessment among Secondary Schools Students of Western Region on the Basis of Locality State wise (Data Source: Table 04)

State	Nature of Management	Level of Scores					
		High		Moderate		Low	
		No. of students	% of students	No. of students	% of students	No. of students	% of students
Chhattisgarh	Government (138)	2	1.45%	118	85.51%	18	13.04%
	Private (0)	NA	NA	NA	NA	NA	NA
Goa	Government (21)	0	0.00%	17	80.95%	4	19.05%
	Private (37)	0	0.00%	34	91.89%	3	8.11%
Gujarat	Government (88)	2	2.27%	84	95.45%	2	2.27%
	Private (53)	2	3.77%	51	96.23%	0	0.00%
Madhya Pradesh	Government (172)	7	4.07%	145	84.30%	20	11.63%
	Private (0)	NA	NA	NA	NA	NA	NA
Maharashtra	Government (109)	13	11.93%	90	82.57%	6	5.50%
	Private (0)	NA	NA	NA	NA	NA	NA

Table 4.21: Entrepreneurship Skills Assessment on the Basis of Nature of Management (Government – Private)

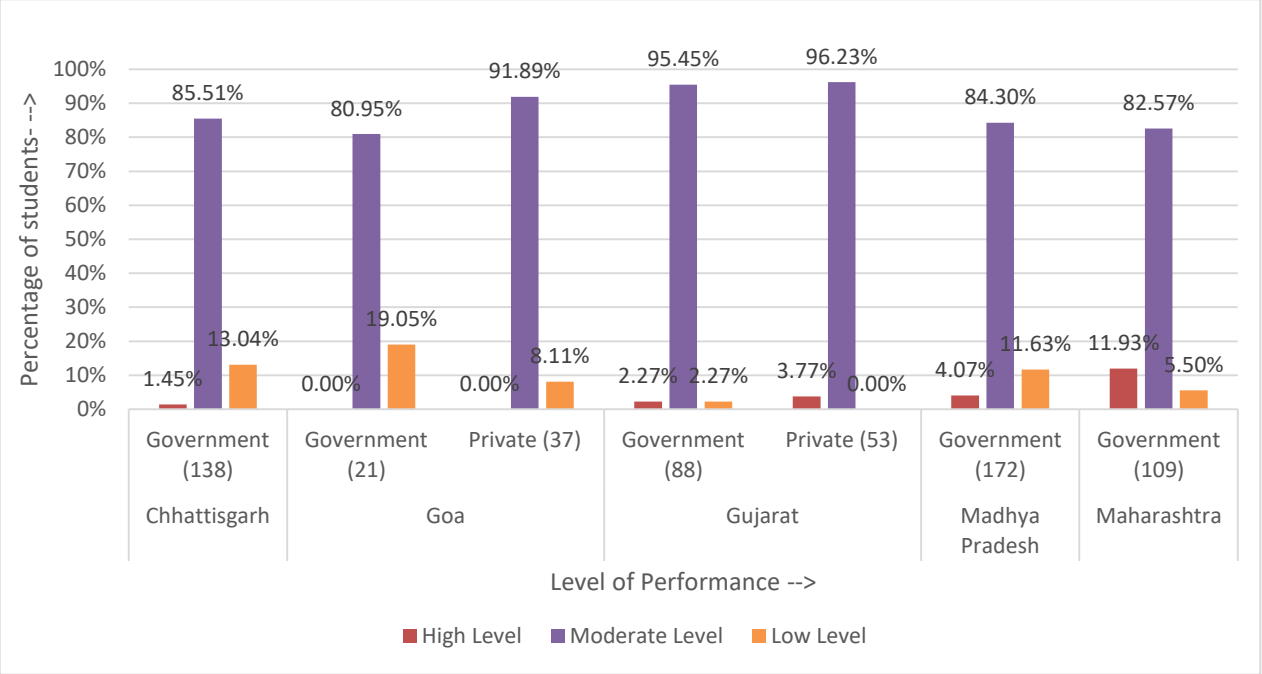


Figure 4.49: Overall Level -wise Performance for Entrepreneurship Skill Assessment among Secondary Schools Students of Western Region on the Basis of Nature of Management State wise (Date Source: Table 05)

DISCUSSION

The chapter presents the results of assessment of entrepreneurship skills among secondary school students in the Western Region, revealing significant insights into overall performance, locality-based performance, and management type. It was that a majority of students (87.22%) possess moderate skills, indicating foundational understanding but lacking advanced competencies. A strong 87.22% of students scored Moderate (22–43), with only 4.21% achieving high scores (>43). This suggests ATL effectively instills foundational business acumen but falls short in nurturing visionary entrepreneurship.

Urban students outperform rural students in high achievement, while rural students dominate the moderate category. The assessment also shows variations based on school management types, with government schools exhibiting more low-achieving students compared to private schools. State-wise data indicates that Gujarat's rural schools have a strong foundational level, while

Maharashtra's urban schools lead in high achievers. Urban areas led in High scores (5.07% vs. 1.83%), likely due to exposure to market ecosystems. Rural dominance in Moderate scores (94.51%) reflects pragmatic, community-focused entrepreneurial thinking.

Government schools reported higher high scores (4.55% vs. 2.22%), contradicting stereotypes. private schools, however, excelled in moderate scores (94.44%), indicating consistent but unexceptional performance.

The overall assessment of entrepreneurship skills indicates that a vast majority (87.22%) of students fall in the moderate category, implying a foundational understanding but a lack of advanced entrepreneurship skills. Additionally, it was found that high-achieving students constitute only 4.21%, indicating a gap in pushing students towards higher entrepreneurial competencies. This suggests that while many students have a basic understanding of entrepreneurship, there is a significant lack of advanced skills. The assessment based on locality reveals that Urban students (5.07%) have a higher percentage of high achievers compared to rural students (1.83%), reflecting the urban advantage in entrepreneurship exposure. However, rural students dominate the moderate category (94.51%), suggesting a strong foundational but underdeveloped entrepreneurial mindset. This indicates that while urban students may have more opportunities for advanced skills, rural students possess a solid foundational understanding.Statewise, the article notes that Gujarat's rural schools show a promising trend with 100% of students falling in the moderate category and none in the low category, while Maharashtra's urban schools have the highest percentage of high achievers (11.93%), indicating an advanced entrepreneurial ecosystem. In terms of management, it states that private school students (2.22%) have fewer high achievers than government schools (4.55%), but their moderate category percentage (94.44%) is higher, indicating more stable foundational learning. Furthermore, the low-achievement category is significantly higher in government schools (9.47%), indicating disparities in implementation. This highlights the differences in entrepreneurial skill levels based on both state and school management types. It will be important to link design thinking and entrepreneurship modules to academic subjects (e.g., math-driven prototyping) and address gaps in thematic integration.

CHAPTER 5

SWOC

ANALYSIS

5.1 INTRODUCTION

In the 21st century of rapid changes, it becomes necessary to bring essential transformations in the field of education also by taking productive initiatives. One of the leading initiatives taken by the Government of India is introduction of the project named Atal Tinkering Labs for school students. But to know the level of extent of this project, it is essential to analyse each and every aspect of this project in best possible way. Strength Weakness Opportunity Challenge analysis is one of the efficient tools which provides the detailed information about both internal and external factors by focusing majorly on these four domains. SWOC analysis not only provides the present status but also gives the opportunity to improve the current situation. This chapter focuses on the strengths, weaknesses, opportunities and challenges of the Atal Tinkering Lab project. It provides the analysis of each domain of SWOC analysis separately by considering major aspects related to this project like how this initiative is helping students, teachers, schools, nation at various levels. It also focuses on weaknesses of this project, various opportunities provided through this initiative and the challenges which shows that there are still some areas which need to be focused for effective implementation and success of this project. This section also provides the relationship among all the domains of SWOC analysis and shows how one domain can affect other and can be utilised for empowering the another domain of SWOC analysis. This analysis can be used for the further development and successful implementation of ATL project.

Inclusion of effective planning, focus, clarity, progress monitoring and perseverance are few elements that lead to achieve SMART goal. For achieving any goal, it is important to know all necessary insights that directly or indirectly have their impact on end result.To get the insight how internal and external factors are having their effect in achieving the desired goal, Strength Weakness Opportunity Challenge (SWOC) analysis is done. The SWOC Analysis is a tool to evaluate the Strengths, Weaknesses, Opportunities and Challenges involved in a projectand is considered as an effective framework plan to achieve certain goals in a specific period of time(Sharath Kumar C.R, 2023).SWOC analysis provides a framework for developing strategies based on an appropriate compound of the strengths, weaknesses, opportunities and threats (Meymand, 2013).This chapter focuses on the Strengths, weaknesses, opportunities and challenges (SWOC) associated with the implementation of Atal Tinkering Labs in Secondary schools. Atal Tinkering Labs is a national level program-by National Institute for Transforming India (NITI Aayog) - the premier policy ‘Think Tank’ of the Government of India(ATAL Innovation Mission). There are certain key objectives of this program and to know up to what extent these objectives are achieved, this SWOC analysis is done.

5.2 SWOC ANALYSIS

Figure 5.1: Introduction to components of SWOC Analysis

5.2.1 THE STRENGTHS ASSOCIATED WITH THE IMPLEMENTATION OF ATAL TINKERING LABS IN SECONDARY SCHOOLS

Students

- Tinkering: Students are getting involved with technology i.e., experimenting with various technology tools like electronics and robotics to understand their potential and use them to find solutions for local and global problems.
- Critical competencies: Atal Tinkering Labs are providing children with resources to ideate, experiment, and address real-world challenges. ATLs are equipping students with critical competencies such as creativity, curiosity, and innovation.
- Skill development: ATLs are inculcating skills such as design mindset, computational thinking, adaptive learning, physical computing etc in students and resulting in overall development of students.

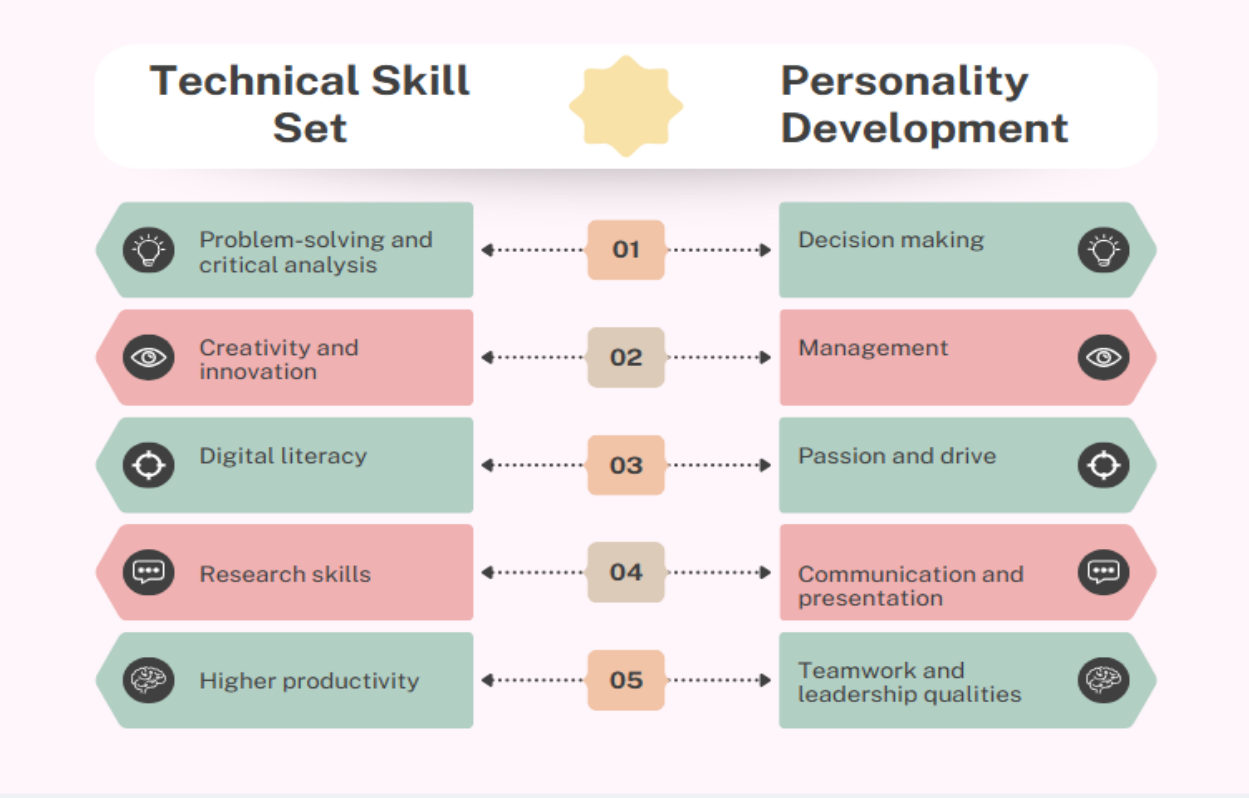


Figure 5.2: Skill set develop through ATLs (Source– Shiksha.com)

- Learning by doing: The more senses involved in learning experience, the better the learning will be- John Dewey who strongly believed in learning by doing. ATLs are emphasizing active engagement with the environment through multiple sensory inputs, making learning more meaningful and impactful.
- STEM Education: ATLs are playing a vital role in promoting Science Technology Engineering and Mathematics (STEM) Education.

Teachers

- Personal and professional development: Atal Tinkering Labs are helping the teachers in glorifying their personal and professional skills. Teachers get the exposuretothetechnologies and concepts used in ATLs which helps them in making the workplace resourceful.
- Effective teaching learning process: Teachers are getting the opportunityto create the learning environment where not only the student learns but the teachers also learn. This program is guiding the educators on how to establish inclusive and engaging learning classrooms that nurture **creativity and problem-solving skills among the students.**

School level

- Some ATLs are opening up their gates to the children from nearby non-ATL schools by conducting open sessions on tinkering and innovation. Some ATLs are even arranging alumni as their resource person for their learners so that they can get better exposure and experience. This is leading towards recognition of school at local and regional level.

National level

- Viksit Bharat 2047: The journey towards Viksit Bharat is ambitious, and with initiatives like the ATL program, India is laying a robust foundation for success. By empowering its youth with the tools and mindset needed to innovate, India is not merely preparing for the future—it is actively shaping it. ATLs cultivating job seekers and creators, fostering an entrepreneurial mindset essential for economic diversification and resilience(Jogeshwar).

5.2.2 THE WEAKNESSES ASSOCIATED WITH THE IMPLEMENTATION OF ATAL TINKERING LABS IN SECONDARY SCHOOLS

- Trained teachers: Lack of knowledge of ATL in-charges about the content, curriculum and teaching methodology is creating hindrance in achieving the desired goal of ATL program. The schools where ATL in-charges are less motivated are not functioning desirably.
- MOCs engagement: There are very few schools where Mentor Of Change are actually engaged with the schools rest others are not getting benefitted through the MOCs as they are neither providing in-person nor online mentoring to the learners.
- Alignment with regular course curriculum: ATL emphasize the students to convert theoretical knowledge into practical experiences but students are still looking ATL as a segregated part. They are unable to align their regular course curriculum with ATL for better learning experiences.
- Support from school: for the successful implementation of ATL program, it is very important to get the positive support from the school and that support can be professional support, essential resources, time and many more. Some schools are not getting adequate support from their school which in result is obstructing the performance of ATL.
- Research & Development: Assessment act as an excellent feedback mechanism which provides the information about the progress of students, teachers and also about the ATL program. There are very few ATLs which are maintaining Rubrics to monitor the student's performance. Since there are no such assessments being done, every ATL is functioning in its own way. Lack of research in this field is creating a gap in the implementation and development of this ATL project.

5.2.3 THE OPPORTINITIES ASSOCIATED WITH THE IMPLEMENTATION OF ATAL TINKERING LABS IN SECONDARY SCHOOLS

- Innovation: Atal Tinkering labs have been envisaged to be the hub for innovation, invention, making, tinkering and giving shape to ideas solving local and global problems using technology. It is giving opportunities for the young students to work and learn in a flexible environment leading to participation in multiple regional and national level competitions and exhibitions at periodic intervals.

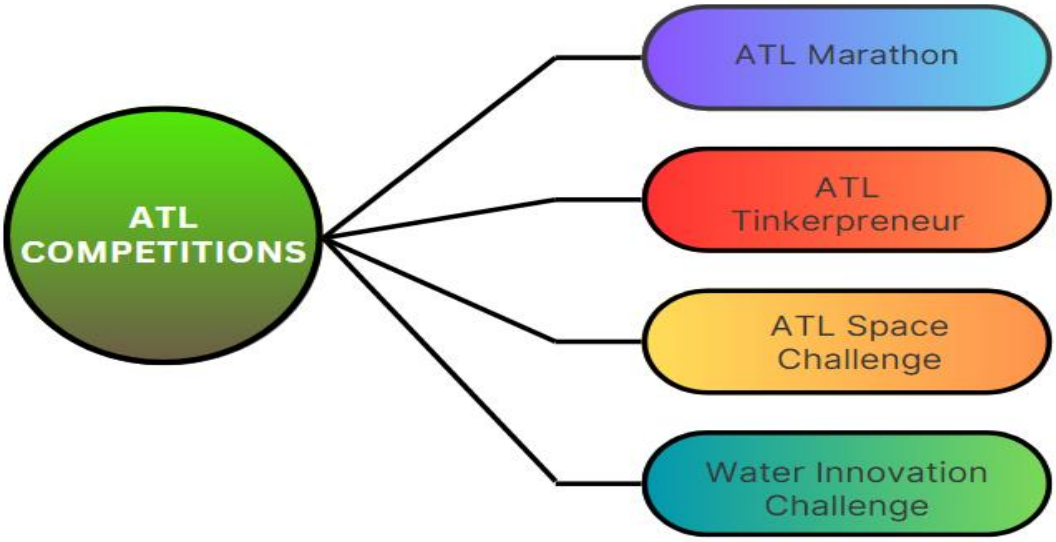


Figure 5.3: Types of ATL competitions (Source- Author)

- Entrepreneurship: Atal Tinkering labs are providing a platform for young students to explore their creativity, problem-solving skills, and entrepreneurial mindset. The boot camps are being organized in summer break that equip the students with 21st century digital *and entrepreneurial* skills to build the digital venture.
- Wall of Fame: This is the platform provided by the Atal Innovation Mission to recognize exceptional works of students and teachers through Atal Tinkering Labs. ATLs allow submitting ATL Wall of Fame Stories; ATL Exemplary Teachers of Change stories and highlights the best ones not only to appreciate them but to motivate others.
- Expanding network: Participation in various government organized competition is helping the schools to expand their network from local to global level.
- Start-up India and Skill India: Atal Tinkering Labs are playing pivotal role in promoting Start-up India and Skill India schemes by developing 21st century skills among the students and giving them opportunities through various competitions. Atal Tinkering Labs are also contributing in MSME Development through the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006.

5.2.4 THE CHALLENGES ASSOCIATED WITH THE IMPLEMENTATION OF ATAL TINKERING LABS IN SECONDARY SCHOOLS

- Management of activities: Managing the activities of ATL with existing curriculum load is becoming challenging for the teachers especially for the secondary school students.
- Time management: There are some schools where no additional period is assigned for ATL along with regular periods. Due to which teachers try to take ATL sessions after school hours which becomes difficult to manage as it is not possible for all the students to stay back after school timings.
- Lack of funds: There are several consumable items in the Atal Tinkering Labs and these items demands sufficient funds on regular basis for proper functioning of ATLs.
- Mentor support: To get the mentor support is a major challenge because even though the MOCs are assigned for the school, only few are actually providing support.
- Encouraging students for ATL: Motivating the students for opting ATL in higher classes is actually challenging. Because of their regular course curriculum and academic pressure, they easily give-up and decide to discontinue ATL.
- Inclusivity: The percentage of participation of boys in Atal Tinkering Labs and the percentage of participation of girls in Atal Tinkering Labs is not same and has a huge difference which shows that equal participation of girls and boys is also a considerable challenge.
- Educational qualification of ATL in-charge: Not having desired educational qualification of ATL in-charge somewhere effects the functioning of ATL.

Strength, weakness, opportunity and challenges should not be seen in segregation especially in ATL as all these four domains are interrelated and interdependent on each other. One of the ATL in-charge of Government School of rural area shared his view regarding the strengths, weaknesses, opportunities and challenges of this ATL initiative that opportunities are not solely provided in ATL but they are created through ATL by thinking differently and being patient throughout. Maintaining the consistency is very important and he believe ’the more you fail, the closer you get to successes’.Utilizing the given resources efficiently is an art which shows that it is not the number of available resources but how one is using the available resources creates the difference. The ATL in-charge of privateSchoolis setting an example by calling the alumni as resource person to provide better exposure to their students.

The level of dedication and enthusiasm of ATL in-charge plays a vital role in defining the extent of success of ATL project. One of the ATL in-charge of Government School of urban area says that she always like to learn new things so after school hours she devotes her time in learning new concepts and techniques related to this field which not only helps her students but also helps in her personal and professional development. Irrespective of all external factors, critical thought process, patience and trust in youself are the major factors which one should consider in ATL.

No doubt strengths, weaknesses, opportunities and challenges are present in everywhere either it can be at personal level or it can be at project level but how one is dealing with each domain to get the best is important. Atal Tinkering Labs are actually setting an example of true learning as it is considering various aspects:

- Promoting game-based learning and project-based learning
- Connecting real world applications with the theoretical knowledge
- Understanding the psychological needs of the student by not imposing quantitative assessment so that student should not feel the burden of scoring good marks and can only focus on learn with fun.
- It is focusing on all three domains- Cognitive, Affective and Psychomotor domain.
- Providing the environment where the student is learning by doing.
- Introduction of the concept of design thinking for innovative solutions.
- Providing recognition from local to global level.

And there are many more aspects which are focused in this initiative for achieving the objectives of 21st century skills. So, by analyzing actual strengths and opportunities of Atal Tinkering Lab initiative, weaknesses and challenges can be easily minimized.

5.3 RELATIONSHIP AMONG SWOC

A SWOC analysis allows us to generate information so that we can evaluate the current situation, identifying areas to improve and grow and address any challenges in achieving goals that have been created for a project or organization but the question is HOW? For this it is important to know the relationship among all the four elements i.e. strength, weakness, opportunity and challenge and it is also necessary to know how one element can affect other.

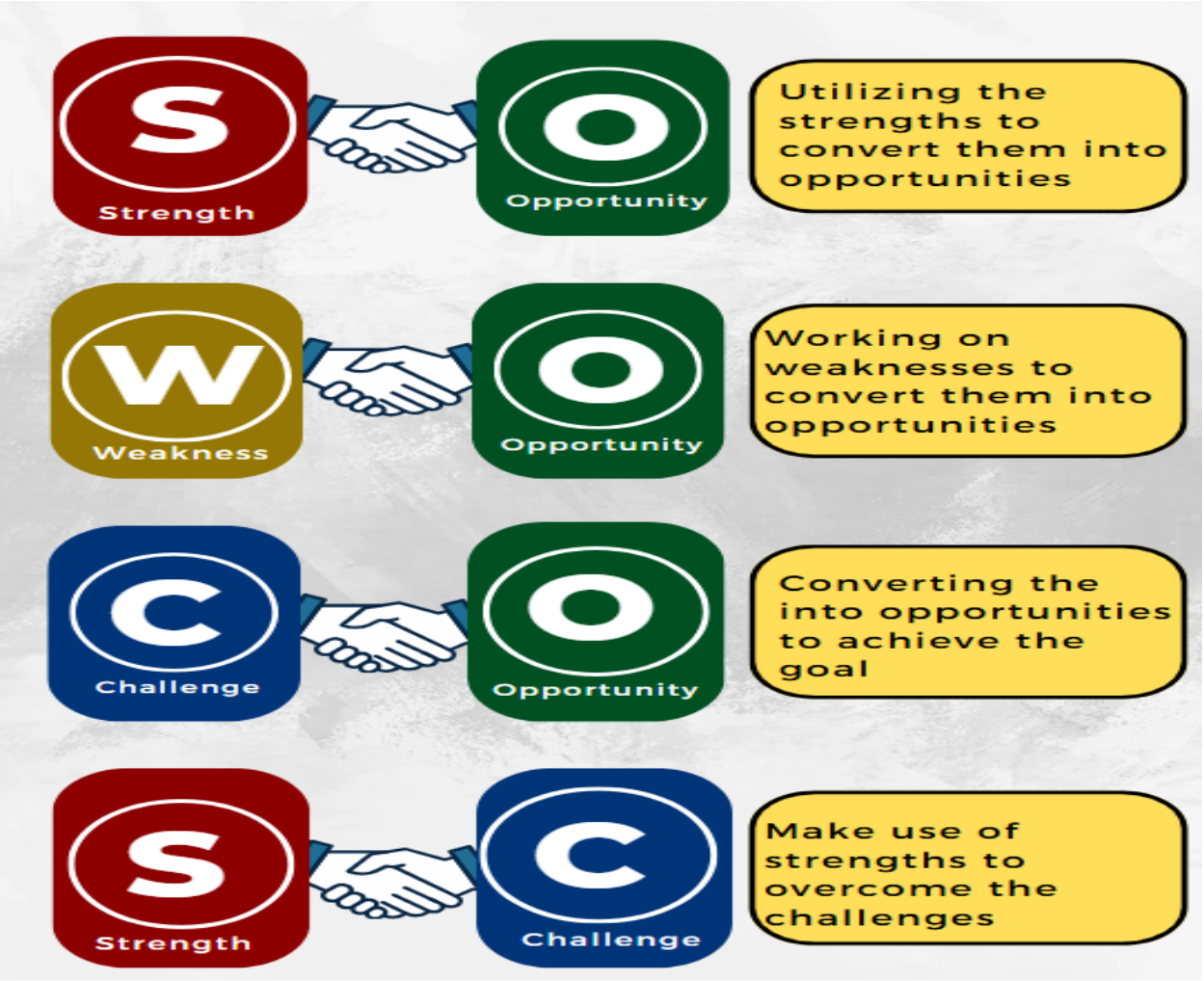


Figure 5.4 : Relationship among strength, weakness, opportunity and challenge

Atal Tinkering Labs are providing best relationships among strength, weaknesses, opportunities and challenges by working in each domain in different ways to utilize the ATL for learning, creating, innovating and achieving the desired goal. Some schools are exceptionally working well by creating opportunities through the challenges, working on the weaknesses and finding best solutions for their issues which show the horizon of ATL project. No doubt schools are trying their best for the success of ATL project and students are actually getting benefitted through this initiative taken by Government of India. SWOC analysis gives the clear picture that Atal Tinkering Labs are effectively contributing in transforming the education system according to NEP 2020 and are helping in achieving 21st century skills. Atal Tinkering Labs are providing multiple opportunities to students, teachers and schools and also giving an opportunity to create opportunities. Whether it can be strength, weakness, opportunity or challenge, each domain has its own significance in functioning of ATLs.

DISCUSSION

Strength, weakness, opportunity, challenge analysis of Atal Tinkering Lab initiative is giving the level of implementation and success of this initiative through which it can be concluded that Atal Tinkering Labs are contributing a lot in bringing positive transformation in education system so as to achieve the objectives of 21st century skills. It is also focusing on the support of ATLs in successful implementation of NEP 2020. This SWOC analysis shows that there are some areas which should be focused for increasing the quality and efficiency of ATL initiative. Understanding each domain in context of ATL and taking required measures can help in achieving the goal of ATL project.

CHAPTER 6

BEST

PRACTICES

6.1 INTRODUCTION

Atal Tinkering Labs (ATLs) were started in different schools with the aim of providing a space were young minds could build, tinker and playthereby creating innovators of tomorrow. Since its inception in the year in 2016, ATLs have been successful in promoting many innovative student projects in different schools. These projects have addressed many local challenges and have used the ATL resources in promoting sustainability and answers to social problems. With the active participation of the mentors these schools have been able to excel in many arenas like organizing workshops, hackathons, and bootcamps. Students of these schools have utilized the ATL resources to its fullest coding, electronics, mechanics, and digital fabrication.3D printers, Arduino, Raspberry Pi, AI kits, and robotics tools. According to Vyas (2024) ATL has helped students to develop new skills and to apply them to real-world problems and has helped more than 1.1 crore students to create more than 16 lakh innovative projects through 10,000 Atal tinkering labs in 35 states and union territories in 722 districts by engaging more than 6200 mentors of change,96% of which are established in government schools (Khanna, 2022).As ATL plays a crucial role in entrepreneurship and skill development, the benefit of ATL should reach maximum number of students. Also ATL can promote STEM education by providing support across all STEM domains. Over the past decade, STEM education in India has experienced extraordinary development and transformation. Both the public and commercial sectors have made significant expenditures to improve STEM infrastructure and curricula because they understand how crucial STEM fields are to fostering innovation and economic growth. ATL can serve as a **catalyst for STEM education**by providing students with hands-on learning opportunities and fostering an **innovation-driven mindset (Mishra and Gupta, 2023).** These labs bridge the gap between theoretical knowledge and practical application, encouraging students to explore STEM fields through experimentation, problem-solving, and real-world projects.Best ATL practices can guide school management and teachers and inspire students to make optimum utilization of ATL resources. They can also replicate the success models in their own schools and ensure impactful and sustainable activities in ATL in the long run.

In this chapter a collection of practices that constitute excellence in Atal Tinkering Labs are presented in brief. These best practices have been identified by a research project funded by NCERT in which the author was Principal Investigator. List of dimensions of excellence (to elaborate the best practices) in ATL has been described in Section 2. The best practices of ATL have been elaborated in Section 3. Student's experiences of ATL are given in Section 4 and take aways from the best practices are given in section 5.

6.2 BEST PRACTICES OF ATAL TINKERING LABS

In general, best practices can cover a wide range of activities, policies or approaches which bring about a positive change in student's performances and attitude in a particular area. While discussing the best practices of ATLs the following dimensions have been covered:

1. Innovative projects aimed at solving community problems-One of the major aims of establishing ATLs was to promote the design thinking approach in school students. Also, a major component of the design thinking approach is empathized. This component involves collecting needs of the society and coming up with creative solutions to solve the problems of the society. Hence ATL projects should be associated with innovations rooted in societal needs.

2. Collaboration with industry- It is very essential for the ATLs to collaborate with Universities, Engineering colleges, local industries, research centers to get both mentorship and support resources to flourish. This can also broaden the perspectives of the ATL incharge facilitating knowledge exchange. Also, schools can collaborate with industries to conduct summer entrepreneurship programs for ATL students.

3. Capacity building of teachers and students- Regular workshops both in online and offline mode by experts in the field can effectively guide the students and teachers involved in ATL. It can open new arenas for them leading to more innovative projects.

4. Infrastructure support- ATLs may require additional resources to go beyond simple projects and undertake innovative projects. These resources may be shared between different schools operating in a given area.

5. Showcasing innovations and participation in competitions- Schools operating ATL should organize completions to encourage and motivate students to take up more ATL activities. They should be encouraged to participate in national and state level competitions organized by different agencies.

6. Active mentorship- To make ATLs a hub of innovation and problem solving ATL in-charges have to play a crucial role. Also AIM has designated Regional Mentor of Changes to support schools in conducting ATL activities. Experts from industries, engineering colleges and other reputed intuitions can also contribute in driving innovation through the ATL. Apart from these alumni of the schools can also contribute to the success of ATL.

7. Project based learning –Students should be encouraged to take STEM projects and use design thinking principles through project-based learning. This can foster their problem solving and critical thinking skills.

8. Skill development- Several technical and STEM skills like coding, IoT, 3D designing, printing, AI, electronics, robotics can be developed through ATL. Apart from this ATL can play a major role in developing 21st century skills of problem solving, critical thinking, creativity, entrepreneurship and collaboration can be developed in students

9. Integration with school curriculum- To ensure that students apply their theoretical knowledge to real world problems it is essential that schools take proper measures to align ATL activities with the school curriculum. This will promote experiential learning and also students will be able to understand theoretical concepts easily. Also students will be able to think beyond the silos of traditional subjects and will be able to establish interdisciplinary connections.

   In studying the best practices, a framework has proposed with specific dimensions. And thereafter the institution specific ATLs are explored and examined within that given framework. A structured interview was conducted with the Principals and ATL in-charges of the schools. The responses received from them have been grouped into the following dimensions: 1. Context 2. Purposes 3. Dynamic 4. Problem Solving 5. Assessment 6. Satisfaction. Figure 6.1 shows the conceptual framework for study of ATL best practices. The responses of these dimensions have been shown in Figure 6.2, 6.3 and 6.4. As can be seen from Figure 1 which was a Government Urban School, the ATL in-charge played a dynamic role in leading the students to innovation and entrepreneurship. A man aged 56 years with post graduate degrees in Mathematics, English and History. He also a Ph.D. degree in interdisciplinary sciences. He has dedicated himself in school teaching and ATL activities with the support of his Headmaster. He has worked with children who are mostly from low socioeconomic status families. He has played a major role in transforming the lives of these children by creating a spark of learning in them. These children who could hardly get two meals who are now successful entrepreneurs. He emphasizes that working in ATL has completely changed the lives of the students. He feels that through ATL he is able to contribute to the society through the community projects conducted by the students under his guidance.

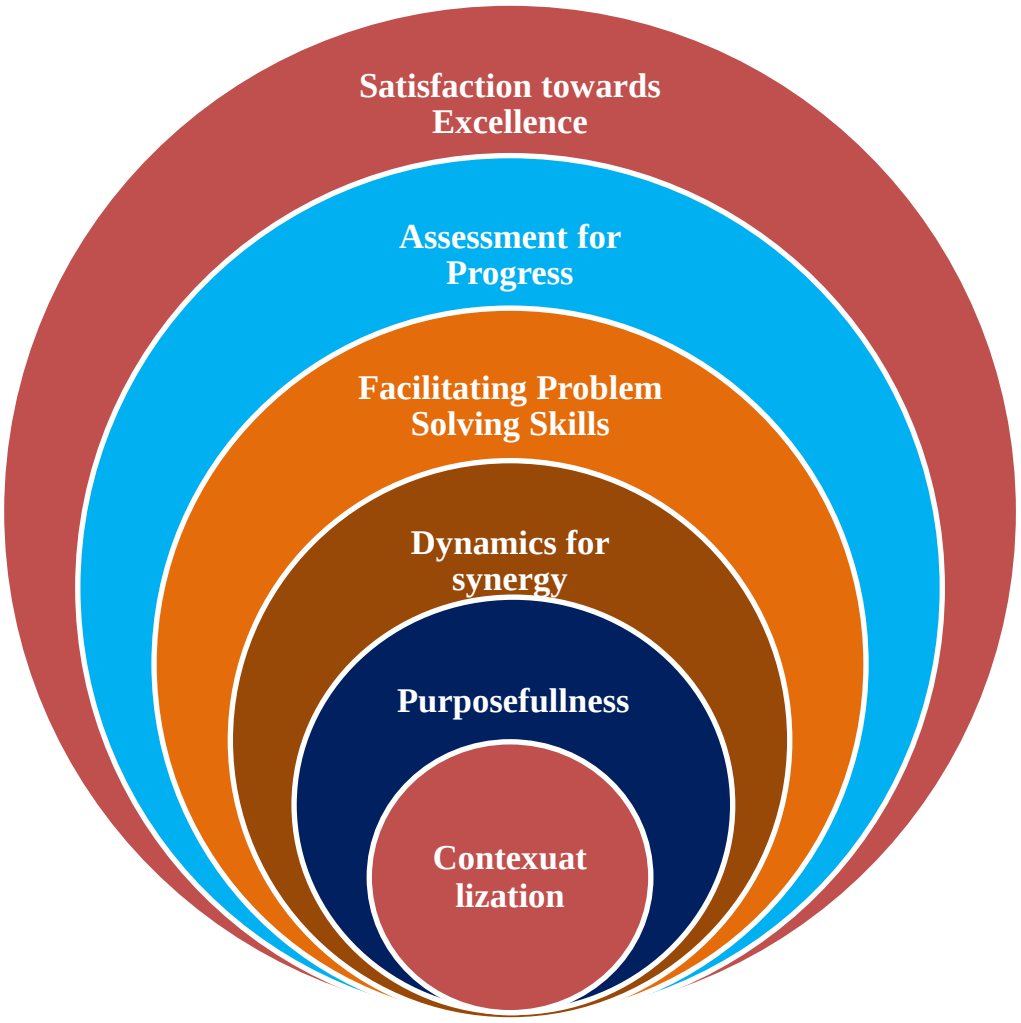


Figure 6.1: Framework for ATL Best-Practices Study

6.3. THE ATL CHANGE-MAKERS

6.3.1 Best practice 1

Government Urban School- The ATL lab of the school was established in the year 2017. A schoolknown for its ATL initiatives, not only at the national level but also at the international level. Several innovative projects were made by the students of this school under the able guidance of their ATL incharge. Best practices followed by the school are:

(i) Students participating in the ATL activities have developed many innovative projects for solving problems of the society. Theyvisit the community and try to understand their needs. The community members are also invited to the school and lab. Different innovation works are carried out in the lab in consultation with the community. Examples of some exemplary projects are

ATAL KRISHI MITRA, MOKCHA, SMART BIO TOILET, and DIVYANG RATH. These innovative projects were carried with the advices of the community and havewon national and international recognition. All these projects had one common thing that they were aimed at providing innovative solutions for societal problems. Hence through these projects the students got a chance to explore real world problems.

(ii) The school has collaborated with faculty of Engineering and degree colleges of the nearby areas to train students in different areas of science and technology. They also regularly invite retired officer's expert in the field of science and technology to orient the students and teachers in ATL activities.

(iii) The school conducted more than 40 webinars during the last five years using different e-learningplatforms such as Zoom, Google meet andWebEx. Experts from different sectors were invited to share their knowledge with the students, teachers of the school along with community students. The school has collaborated with several higher education institutions including IIT Mumbai, IIT Delhi, Central Universities, Dell Hope Foundation and Rasberry Pi.

(iv) The ATL in-charge of the school was successful in arranging extra resources for the lab from different organizations to support innovative projects undertaken by the students.

v) The school was listed in NITI AAYOG "Wall of Fame" in 2020 and has many participated in many competitions like Atal Tinkering Marathon, MAKEATHON and AI Project Based Competitions. They also received the CSIR Award in 2019. They organized state level innovation camp "Tinkerathon" in 2024. They were also thewinners of INNOVATION CHALLENGES, Chandigarh in August 2024. The school secured firstand third positions in Student Innovator program (SIP) At MIT ADT UNIVERSITY PUNE in 2025.

vi) The ATL incharge of the school has left no stone unturned to take the ATL of the school to new heights. Under the leadership and vision of the ATL incharge the students could develop many innovative projects. Under the guidance of the ATL incharge the lab has transformed into a center of excellence, inspiring students to become innovators, problem-solvers, and future entrepreneurs. The ATL charge has received the exemplary teacher award by AIM, NITI AAYOG.

vii) The project-based learning approach has led the ATL to many innovations. Projects like Mokcha , cartech ,water hycinath farming , DivyangRath,AtalkrishiMitra , swasudhtantra ,mental Masti , doctor robo , foot Erection device , foot relaxo shoe , mathematical board , green shield , Rakchneer , automatic warning system , ecogym , food tourism, bhojanapp,crofter juice, rangoli involved active student participation.

viii) The school has been continuously upgrading the ATL Lab in thefield of Robotics and Mechanics to promote skill development. The school has also promotedskill development in the field of carpentry to allow the students to develop skills to make viable productsto enable the Students to be familiar with the concept of Entrepreneurship. They have also successfully patented two of their projects as an outcome of the ATL activities. Studentfromtheschool have attended workshopsconducted by DEL, IBM, and MIT UNIVERSITY PUNE. Electronic gadgets wereprovided to all Students after receiving the donations from an NGO.

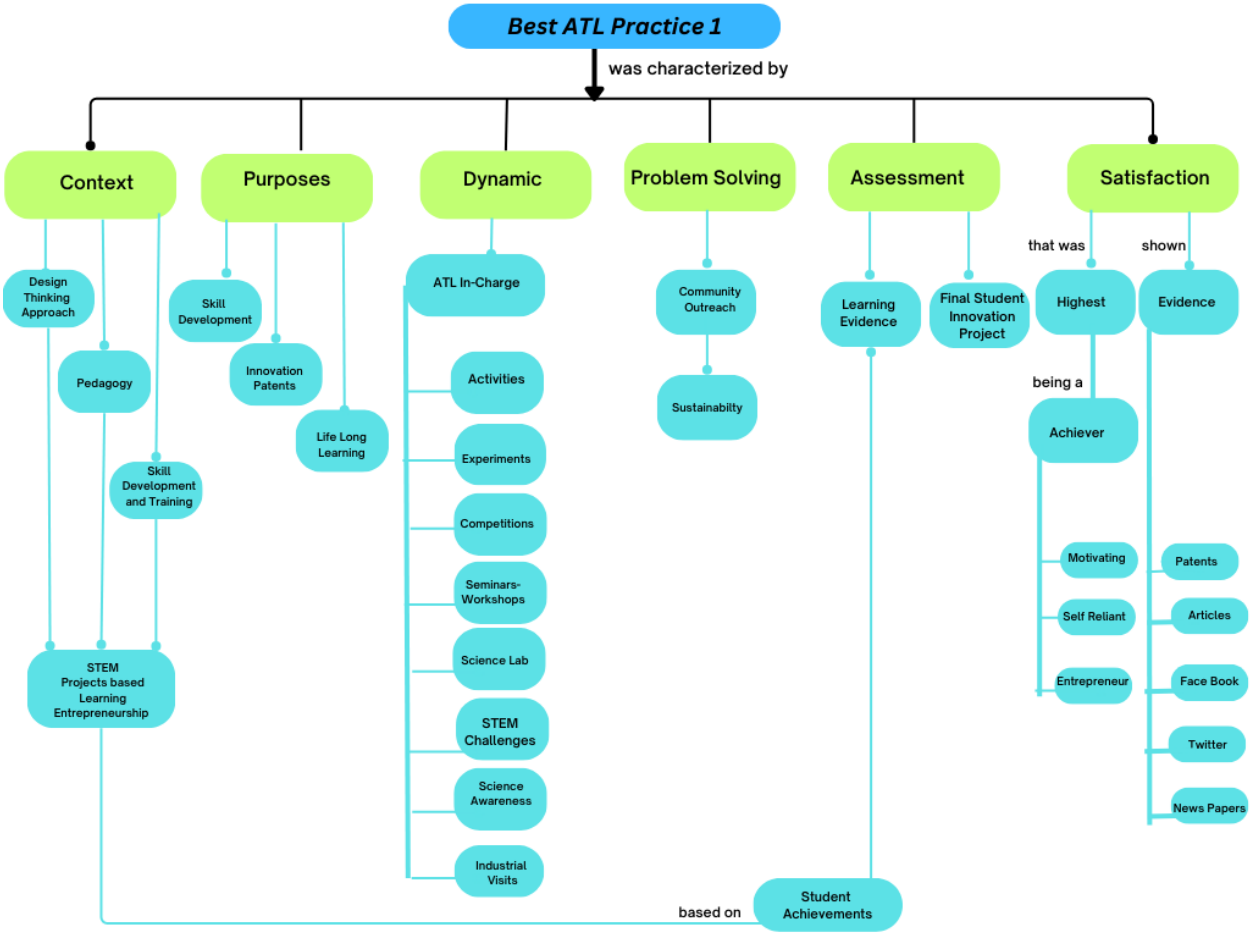


Figure 6. 2: Experience 1 of Best ATL practice

6.3.2 Best Practice 2

Government School Urban- The ATL Lab of the school was established in 2019. Since its inception the school has worked in a planned manner to promote learning through ATL. Best practices followed by the school are:

(i) Through well-defined ATL curriculum made by the school management the ATL lab has been successful in conducting many projects like earthquake alert system, earthquake proof buildings were aimed at solving real world problems.

(ii) The school has signed MOU with STEMbotix an EdTech start-up that offers comprehensive solutions in robotics, coding, STEM education, AR, VR, 3D printing, computer vision, animation etc. Students regularly undertake industrial visits

(iii) The school regularly invites experts from industries and institutes of national importance to train the teachers and students on latest technology.

(iv) The school regularly conducts workshops, webinars and science exhibitions in which the students actively participate. About 300 projects are received in a single exhibition.

(v) The school has participated in the World Robotic Olympiad Competition in 2024, in regional science fairs, in interschool project competition; ATL Marathonand has won many prizes.

(vi) The ATL incharge had established the requisite conditions to facilitate innovation and entrepreneurship in ATL. He is available in the lab even after school hours and promotes the open lab concept wherein students can visit the lab even after school hours on selected days.

vii) Using the ATL lab students were encouraged to undertake many projects like air pollution monitoring system, social distance alarming project, astronomy projects, working model of SMART farming project, 3d model of home/car/robot etc. Wireless Parking System, Toll Tax Collection System

viii) Several technical and STEM skills like coding, IoT, 3D designing, printing, AI, electronics, robotics were developed intheATL. Assessment of the students based on a rubric revealed that the ATL played a major role in promoting problem solving, critical thinking and creativity in the students.

(ix) The curriculum of ATL was well planned and aligned with the school curriculum. This helped in strengthening the theoretical knowledge of the students with practical experiences.

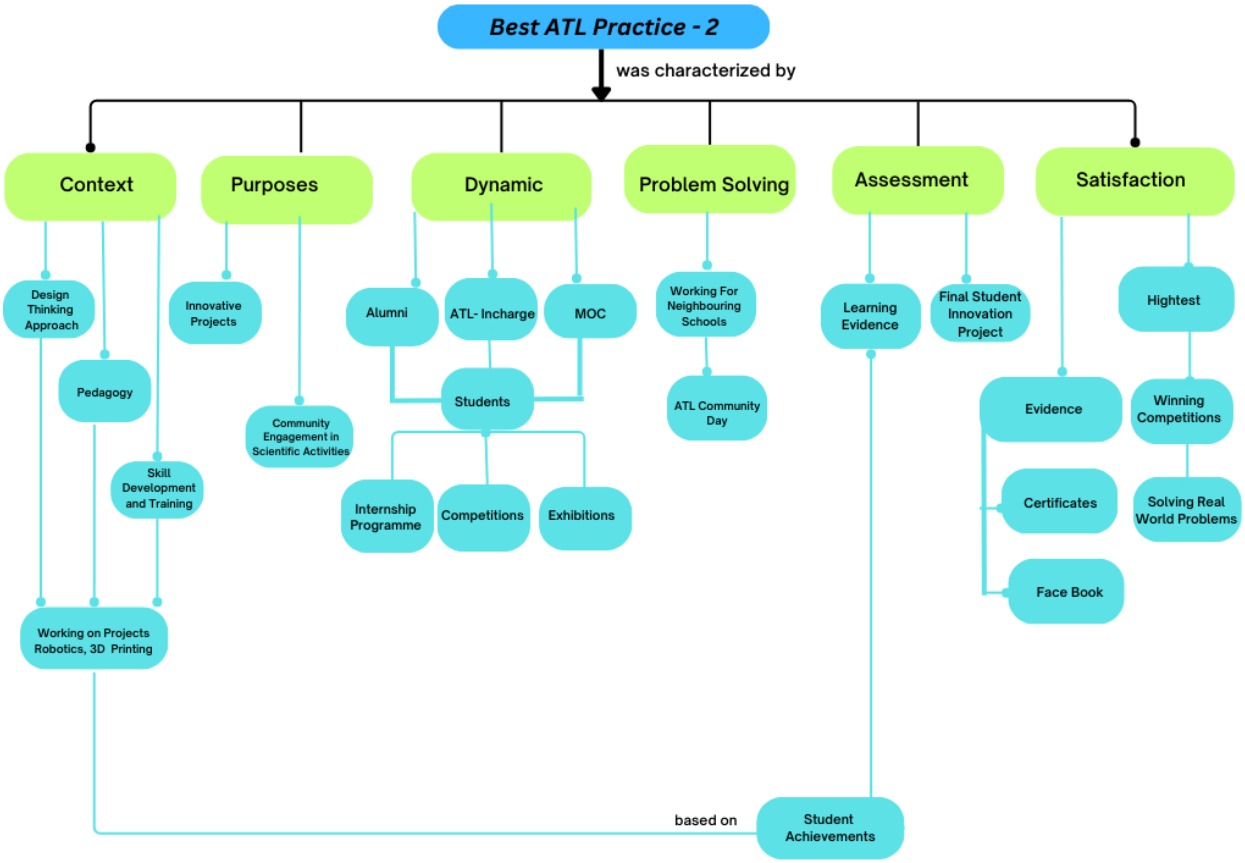


Figure 6. 3: Experience 2 of Best ATL practice

6.3.3 Best Practice 3

Private Rural School-

(i) Students participating in ATL activities have made many innovative projects like mechanical bullock cart, smart hospital bed,smart food utilizer using the design thinking approach to solve local community problemsEDU play app,pencil dispenser, class alarm, TE BUD app, smart iron, cylinder alarm system, stadorium, automecbell.

(ii) School has partnered with Hope foundation and Prathaminfotech NGO to provide training to the teachers and students of the school. Senior students were given opportunity to teach their peers and junior lab mates.School is also collaborating with faculty ofengineering colleges to provide guidance to the teachers and students in ATL relate activities.

(iii) The school has conducted online ATL mentor workshops, sensitizationworkshop on innovation and creativity, workshop on Introduction to Hardware and Robotics, ATL summer camp on basic electronics, student Internship program by AIM and IBM, workshop on Mechanzo by RobotechPvt Limited, workshop on introduction to DC cars and Drone Technology, Hands on workshop on 3D- modelling, Design Thinking, Movie making and animation.

(iv) The school won in thewestern India science fair Student, got first position in Techyon in 2018-19. Students were awarded internship program for being in top 300 ATL marathon projects. Students took part in ATL Marathon every year.

(v) The active role played by the ATL incharge has led to the development of many innovative projects. Teachers of the school provide full support to the ATL in-charge.

(vi) Through the ATL lab students were encourage to undertake many projects like air pollution monitoring system, social distance alarming project, astronomy projects, working model of SMART farming project, 3d model of home/car/robot etc.

(vii) Students are given enough opportunities to build their technical skills through coding, 3D designing and printing, robotics etc. They work collaboratively in the lab and come up with many innovative projects.

(viii) The ATL curriculum has been well planned, dynamic, and aligned with future skills for different stages of education. Teachers of the school are encouraged to use the ATL resources in their regular classes to remove the extra burden of ATL activities.

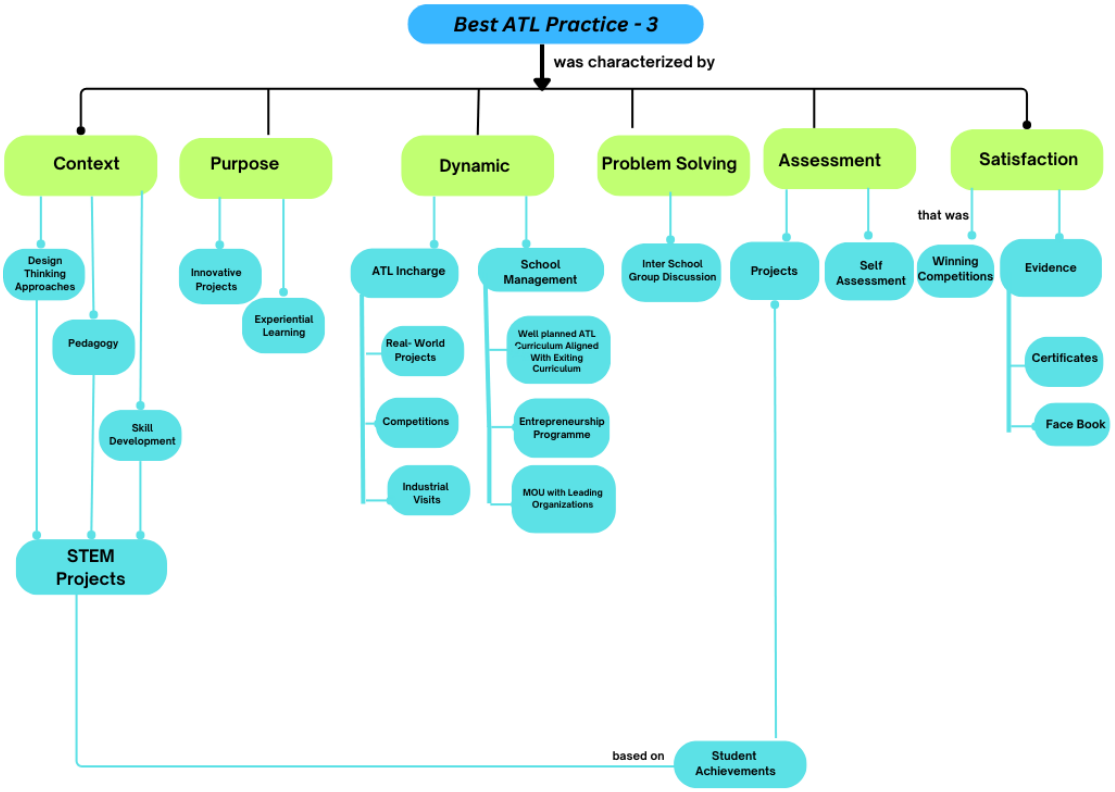


Figure 6.4: Experience 3 of Best ATL practice

For the Best practice 3 the ATL incharge who is a lab assistant emphasizes that the support of Principal and other teachers of the school has given a boost to the ATL activities. Their collaboration with neighboring institutions and schools has been fruitful. Also students are very enthusiastic towards STEM learning in ATL. He feels that the flexible environment in his school has promoted the ATL. A glimpse of student activities for best practice 1 is shown in Figure 6.5, for best practice 2 it is shown in Figure 6.6 and for best practice 3 it is shown in Figure 6.7.

6.4 STUDENT'S EXPERIENCES OF ATL

Reflections of some students from the above schools are given on their experience in ATL

"All required materials are available to make projects. We get enough opportunities to participate in competitions and get to know about new technology. This helps in bring our ideas to life. There are no restrictions in the lab and we have the freedom to speak our mind and ask questions." Student 1Class 9

“I worked in my ATL Lab when I used to get free time. My ATL is exceptional as it provides a chance to explore the hidden Skills of students and drives us into the journey of innovation and entrepreneurship”. Student 2 Class 10

“I was an ordinary student from the beginning. I met my passion with creativity in ATL of my school. Now I have Expertise myself in video making both normal video and cartoon Video, by the technical assistance of the lab. This is helping me to earn my livelihood from a young age only. I am enjoying my work in the lab. I had represented India in G20 Summit also”. Student 3 Class 10

“The ATL in-charge of our school treats us like his family. The lab Provide us the technical Expertise in all form as in Coding, Mechanics, Electronics and others with the assistance of the personals from IITs and NITs. We are from the ordinary family background in terms of economy and have never dreamt of participating in all such projects. This Lab also helps us mental wellbeing by reducing Stress with the help of NLP AND HUNA “. Student 4 Class 10

“The lab has given me hands-on experience in building robots and programming them.I joined because i wanted to create something meaningful and learn about the future of technology”. Student 4 Class 10

“The robotics lab has been an incredible experience. I joined to learn coding and mechanics and now I am able to create functioning robots that I am proud of”.Student 5 Class 9

“Working on real-world projects in the Robotics lab has helped me understand engineering principles in a practical way. I joined to challenge myself and learn something new every day”.Student 6 Class 10

“I am fascinated by how to build robots from scratch it has given me the tools to design my own.The projects are challenging, but I am learning a lot”. Student 7 Class 10

Figure 6.5: A glimpse of ATL activities conducted by School 2

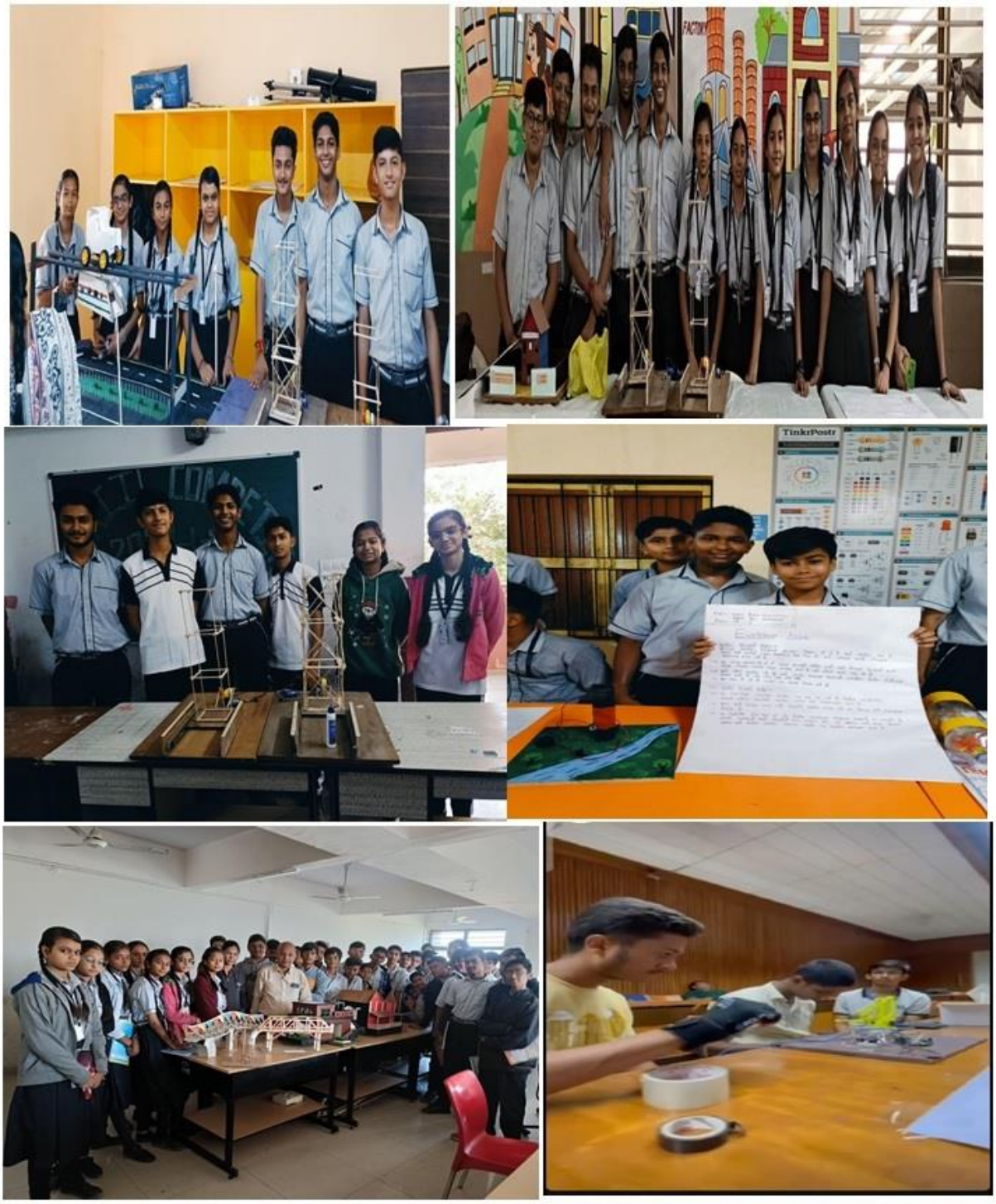


Figure 6.6: A glimpse of ATL activities conducted by School 2

Figure 6.7: A glimpse of ATL activities conducted by School 3

6.5 TANGIBLE TAKE-AWAY FROM THE BEST PRACTICES

The common aspects of the best practices presented in this chapter are as follows:

1. Key role of ATL in-charge- The ATL in charges can serve as agents of change leading the students to innovation and entrepreneurship. Their commitment to educational innovation through ATL has played a major role in transforming their ATL into 21st century knowledge hub. Their commitment of using active learning methodologies and engaging maximum number of students in ATL has reaped the desired rewards.

2. Sustained Impact of Continuous Practices in ATL- To transform ATL into a sustainable hub of knowledge, continuous practices over a long period of time are essential. By implementing consistent, structured, and evolving ATL programs, schools can sustain innovation, develop real-world skills, and empower students to be lifelong learners and entrepreneurs.

3. Student motivation –Discussion with the students revealed that there was a high satisfaction in the experiences of the students in ATL. The major factors that contributed towards this are student clubs, collaborative learning, empathy driven projects, tinkering based learning and working on real world projects. The best practice schools have created an engaging, student-driven ecosystem where students stay curious, confident, and innovative in a free atmosphere.

4. Assessment- A well-structured assessment practice was followed by these schools. The assessment was holistic, project based and skill oriented. Students were assessed under various dimensions like practical work, projects, hackathons, design thinking, presentations. The feedback was regularly shared with the students. Self-assessment of the students was also done on a regular basis. This helped the students in evaluating their progress and skill.

5. Showcasing of ATL events- These best practice schools have effectively showcased their activities and projects which has not only helped to inspire the students but also has enhanced community engagement, and recognition at national and global levels. Also they have been able to arrange for extra resources for their ATL from different organizations through the show casing strategy in the form of physical resources, sponsorship, mentorship and partnerships.

6.6 DISCUSSION &CONCLUSIONS

The Atal Tinkering Labs (ATL) has introduced a set of best practices that have significantly enhanced innovation-driven learning in Indian schools. The generic best practice is hands-on based experiential learning that where students actively engage in designing, prototyping, and problem-solving using most effective modern tools this fosters creativity, critical thinking, and design-based learning. In general mentorship program, peer learning and collaboration and community engagement by addressing the common people's challenges the ATL is unique in nature. The present articles further reflects the research based findings of the status of the best practices and what are the uniqueness exhibited and demonstrated by some best performing ATLs are cross examined here. These best practices collectively ensure that ATL projects nurture a culture of innovation, entrepreneurial thinking, and problem-solving among students, preparing them to thrive in the 21st-century knowledge economy.

The best practices presented in this chapter have their own particular experiences but all of them have been able to facilitate student learning and skill development through ATL. Other schools may adapt these best practices to transform their ATL into a more dynamic place of learning and innovation. These best practice models can serve as a guide to teachers who wish to promote innovation, problem-solving, and entrepreneurship through ATL. These practices can be further refined by the teachers and school management to build an ecosystem of young innovators, problem solvers and global citizens. To scale and sustain the ATL initiatives these best practices can show a pathway to the policy makers to ensure maximum utilization of ATL.

CHAPTER 7

MAJOR FINDINGS

And

RECOMMENDATIONS

7.1 INTRODUTION

The Atal Tinkering Labs (ATL) initiative, launched by NITI Aayog, has been instrumental in fostering creativity, critical thinking, and problem-solving skills among students across India. However, to maximize its impact, restructuring is needed both from policy perspectives and programme design. A revised approach can ensure that ATL aligns with contemporary educational needs, technological advancements, and socio-economic demands, drawing from global best practices in innovation-based education, such as the United Kingdom's STEM Learning Programme, Finland's Phenomenon-Based Learning, and the United States' Maker Movement initiatives (Blikstein, 2013).

From global and national policy discourse, any noble education should encourage a multidisciplinary learning culture. The current ATL framework focuses predominantly on science and technology, often overlooking the importance of integrating other disciplines such as the humanities, social sciences, and arts. Finland's Phenomenon-Based Learning model emphasizes cross-disciplinary, real-world problem-solving, which is a good precedent of a wider spectrum of disciplinary engagement that has been effective in terms of learning outcomes (Birgit & Lili-Ann 2024). For ATL's multidisciplinary expansion by adopting a similar approach, policy revisions should mandate a multidisciplinary approach that encourages students to apply their scientific knowledge in varied domains in the context of the intersectionality of science and social science.

While ATL promotes hands-on learning, a more focused, structured framework for experiential and inquiry-based education needs to be integrated into policies. The Maker Movement in the U.S. has demonstrated the power of experiential learning in boosting creativity and independent problem-solving (Blikstein, 2013). Encouraging students to explore real-world challenges rather than following pre-designed projects, as seen in the Project-Based Learning (PBL) approach in Australia, will enhance their ability to think independently and innovate effectively (Thomas, 2000).

With the increasing role of digital tools in education, policies should focus on ensuring digital literacy, providing access to updated resources, and incorporating virtual and augmented reality tools. Estonia’s successful digital education policies, which integrate coding and AI from primary school levels, are relevant to the present context. How then regenerative AI can be integrated more effectively with ethical compliance is the need of the hour for ATL restructuring policy initiatives. The last decade has been documented research findings that embrace ‘design approaches’, and, notably, design thinking, have pointed to experiential and action-oriented methods that are best suited for innovation and entrepreneurship education (Arendt, 2024).

ATL should transition from merely fostering tinkering to promoting structured research and innovation. The UK's STEM Learning Programme, which encourages early-stage research and project-based experimentation, provides a compelling example of how structured research opportunities can elevate the scope and quality of research-minded learning. By promoting conducive policy, ATL from a basic innovation platform needs to a recognized research incubation center.

As far as programme design is considered, there is room to accommodate further innovation in the unique design of ATL Programme. Integration with curriculum and interdisciplinary learning through ATL should be a priority. Currently, ATL operates as a non-compulsive initiative rather than being seamlessly integrated into the academic curriculum. The research outcome of the Finnish education system's interdisciplinary approach may a good reference here. ATL might be redesigned to embed innovation activities within the syllabus, ensuring students apply theoretical knowledge to practical problems more effectively.

ATLs should evolve into full-fledged knowledge and innovation hubs where students, teachers, and external stakeholders collaborate to develop solutions to pressing social and technological challenges. This mirrors the Fab Lab movement, which originated at MIT and has been adopted in various countries as centers of grassroots innovation (Gershenfeld, 2005). To prepare students for future careers, ATL must emphasize skills such as critical thinking, problem-solving, communication, collaboration, and adaptability. Studies from the World Economic Forum (2018) highlight that interdisciplinary and project-based learning models, such as Germany's Dual Education System, equip students with industry-relevant competencies. It is a good opportunity to explore other such experiences while integrating skills through ATL programmes to make learners either industry-ready or for industry-compliant tertiary education.

Currently, ATLs operate largely on government grants. To make them self-sustaining, at least to a certain extent, they should explore revenue-generation models, such as providing consultancy services, conducting paid workshops, collaborating with industries for product development, and patenting student innovations. Countries like Israel have successfully implemented startup incubation models in schools, promoting student entrepreneurship (British Council, n.d.). To encourage and provoke innovations, ATL may be granted greater autonomy to tailor its programmes according to local needs and available resources. This includes allowing flexibility in resource allocation, curriculum adaptation, and engagement with external experts. Decentralized education models, such as Canada's individualized learning strategies, provide a valuable reference for ATL's restructuring.

To ensure equitable access, ATL should expand its reach to underserved communities, rural areas, and differently-abled students. The UK's STEM Ambassadors Programme has successfully engaged underprivileged students in STEM fields, which ATL can replicate to bridge the urban-rural divide (Archer et al., 2012). With growing concerns over climate change, ATL should include sustainability and environmental innovation in its objectives. Countries such as Sweden have implemented green schools and climate education programmes, which can be integrated into ATL's initiatives to promote sustainability-focused innovation (Wals & Corcoran, 2017). Currently, there is a lack of systematic assessment and feedback mechanisms to evaluate ATL's impact. Borrowing from Singapore's STEM assessment models, ATL should introduce well-defined frameworks to track student progress, measure innovation outcomes, and incorporate feedback from educators and stakeholders (Tan et al. 2021).

Teachers play the most critical role in the success of ATL, but many lack the necessary skills to guide students in cutting-edge technologies and innovation-driven learning. Drawing from Singapore's teacher training programmes that emphasize continuous professional development in STEM (Tan et al. 2021), ATL policies should focus on training teachers in emerging technological trends, exposure to global best practices, and collaboration with industry experts. The whole institutional ethos needs to be reshaped so that a synergy may be orchestrated towards the mission of innovation and entrepreneurship through ATL.

7.2 MAJOR FINDINGS OF THE STUDY

Based on the research following are the major findings:

- The analysis of usage of Atal Tinkering Lab (ATL) across various states in western India reveals significant trends in both rural and urban schools from student's perspective. Urban schools in Chhattisgarh exhibit the highest daily usage of ATL, with many students participating weekly. Most students engage in ATL activities for 1-2 years, benefiting from consistent support from ATL in-charges. Accessibility to ATL facilities outside school hours is notably high in rural Madhya Pradesh. A strong interest in science and technology emerges as the primary motivational factor for participation, positively influencing students' career choices and reinforcing the role of ATL in promoting STEM education. Over the last decade, substantial investments in STEM

infrastructure and curricula have been made by both public and private sectors, recognizing the importance of STEM fields for innovation and economic growth.

- In Goa and Gujarat, private school students demonstrate higher engagement in ATL activities than their government school counterparts, with notable disparities in support and accessibility. Specifically, private school students in Goa attend ATL weekly at a higher rate (78.38%) compared to Gujarat (65.00%). Conversely, government school attendance is lower in Goa (9.52%) than in Gujarat (50.75%), with most government school students in Goa rarely attending ATL. Accessibility to ATL facilities is greater in private schools than in government schools, especially in Goa (56.76% for private schools) compared to Gujarat (30%). Students from both sectors exhibit a strong motivation to participate in ATL, driven by their interest in science and technology, reflecting similar trends observed across different states.

- The analysis of ATL (Atal Tinkering Lab) in-charges reveals a high availability of essential tools and equipment in schools, with 86.95% reporting access to electronics, robotics, and IoT, and 91.30% for mechanical and electrical tools. This infrastructure supports STEM integration, with 52.17% of incharges effectively integrating science and technology concepts. However, only 26.08% reported having MOUs with other institutions, indicating a need for improved collaboration.

- Student engagement in ATL programs is structured but varies by interest, with high participation in workshops and seminars, but lower involvement in industry visits and specific programs like AIM Hackathon. Teachers report functional tools, with 85.71% for electronics and robotics in urban schools, while rural schools lag in grant support (18.75% for Tranche 2).

- Integration of ATL activities into the curriculum is perceived as more effective in rural areas (56.25%) compared to urban areas (42.85%). Additionally, ATL positively influences career prospects, with 85.71% of urban respondents finding it effective compared to 56.25% in rural areas. Private schools view ATL more favorably than government schools, with 60% of private incharges reporting effective integration versus 50% in government schools, and a stronger perceived impact on educational outcomes. This disparity suggests that funding differences may affect the performance of government schools in ATL initiatives.

- Student performance was categorized into three levels: high (17.31%), moderate (69%), and low (13.27%). The analysis reveals that rural students (21.34%) outperform urban students (15.86%) in high achievement, although moderate scores are prevalent in both groups. This suggests that while ATL has a stronger impact in rural areas, interventions are necessary to improve overall academic performance.

- The findings indicate that government schools report higher high scores (17.80%) compared to private schools (14.44%), which have a larger low-performing cohort (27.78% vs. 10.80%). This challenges the notion of private sector efficacy, possibly due to ATL's equitable resource distribution in government institutions. Regional disparities are evident, with Chhattisgarh's rural students excelling (32.65% high) while Goa's rural cohort struggles (58.82% low). The data highlights systemic inequities, particularly in private schools in Goa and Gujarat.

- The overall distribution of scores shows a predominance of moderate performance (69.42%), indicating that while ATL fosters foundational competencies, it is less effective in cultivating advanced mastery. The absence of a "Very High" category limits the assessment of top performers. The chapter concludes that differentiated instruction and advanced modules are needed to support high-potential learners, and further investigation into the factors contributing to rural students' higher performance is warranted.

- The performance of students in design thinking assessments, revealing a significant concern: 66.67% of students fall into the low skill category, with only 2.10% achieving high scores. This trend indicates a critical deficit in creative design thinking skills, essential for 21st-century education. The analysis, segmented by locality, management type, and state, uncovers disparities, such as Madhya Pradesh's urban schools having the highest percentage of low-skill students (75.66%) and Maharashtra’s government schools achieving 19.27% high scores. Interestingly, Gujarat's rural schools show 13.79% of students with high design thinking skills, likely due to effective mentorship programs. Rural students slightly outperformed urban peers in high scores (4.88% vs. 1.10%), while urban areas excelled in moderate scores (29.52% vs. 35.98%), suggesting rural adaptability fosters grassroots innovation. Management-wise, private school students (3.33%) slightly outperformed government students (1.89%) in high design thinking skills, yet both types show high low-skill percentages (government: 66.86%, private: 65.56%). The findings emphasize the need for strategic interventions to enhance design thinking competencies, particularly by replicating successful mentorship models from Gujarat in low-performing states like Maharashtra.

- Results of entrepreneurship skills among secondary school students in the Western Region, reveal that 87.22% possess moderate skills, indicating a foundational understanding but a lack of advanced competencies, with only 4.21% achieving high scores. Urban students outperform rural students in high achievement, while rural students excel in the moderate category. Variations based on school management types show that government schools have more low-achieving students, while private schools perform better in the moderate category. State-wise, Gujarat's rural schools demonstrate strong foundational skills, while Maharashtra's urban schools lead in high achievers. Overall, the assessment indicates a significant gap in advanced entrepreneurial skills,

emphasizing the need for improved integration of design thinking and entrepreneurship in academic subjects to address these disparities.

- Atal Tinkering Labs (ATLs) are engaging students in technology through hands-on experimentation with tools like electronics and robotics, enabling them to address local and global challenges. These labs foster critical competencies such as creativity, curiosity, and innovation while promoting skills like design mindset, computational thinking, and adaptive learning, leading to overall student development. Emphasizing John Dewey's principle of "learning by doing," ATLs enhance learning experiences through active engagement and sensory involvement, significantly contributing to STEM education.

- For teachers, ATLs enhance personal and professional development by exposing them to new technologies and concepts, thereby enriching the learning environment for both students and educators. This initiative encourages inclusive and engaging classrooms that nurture creativity and problem-solving skills.

- At the school level, some ATLs are extending their resources to students from nearby non-ATL schools, facilitating open sessions on tinkering and innovation, and involving alumni as resource persons for enhanced learning experiences. This outreach is fostering recognition for schools at both local and regional levels.

- On a national scale, initiatives like the ATL program are foundational to India's vision for Viksit Bharat 2047, empowering youth with the tools and mindset necessary for innovation. This approach aims to cultivate both job seekers and creators, fostering an entrepreneurial spirit vital for economic diversification and resilience.

- The effectiveness of the Atal Tinkering Lab (ATL) program is hindered by several factors. Firstly, a lack of knowledge among ATL in-charges regarding content, curriculum, and teaching methodologies affects program outcomes, especially in less motivated schools. Additionally, the engagement of Mentors of Change (MOCs) is minimal, with most schools not benefiting from their support, either in-person or online. Students struggle to integrate ATL with their regular curriculum, viewing it as a separate entity rather than a cohesive part of their learning. Furthermore, adequate support from schools, including resources and time, is crucial for the program's success, yet many schools fall short in this area. Finally, the absence of consistent assessment and research limits the ability to monitor student performance and overall program effectiveness, leading to varied implementations across different ATLs.

- Atal Tinkering Labs serve as innovation hubs for students, fostering creativity and problem-solving through technology to address local and global challenges. They provide a flexible

learning environment that encourages participation in regional and national competitions. The labs also promote entrepreneurship by offering boot camps during summer breaks, equipping students with essential digital and entrepreneurial skills. The Atal Innovation Mission recognizes outstanding contributions from students and teachers through the Wall of Fame platform, motivating others to excel. Additionally, participation in government competitions helps schools expand their networks internationally. Atal Tinkering Labs contribute significantly to initiatives like Start-up India and Skill India by cultivating 21st-century skills and supporting MSME development under the MSMED Act, 2006.

- The management of Atal Tinkering Labs (ATLs) is increasingly challenging for teachers, particularly in secondary schools, due to several factors. Time management issues arise when no additional periods are allocated for ATL, forcing teachers to conduct sessions after school, which not all students can attend. Financial constraints hinder the procurement of necessary consumables for proper ATL functioning. Mentor support is limited, with only a few assigned mentors actively providing assistance. Additionally, motivating students to continue with ATL amid academic pressures is difficult, leading many to discontinue participation. There is also a significant gender disparity in participation rates between boys and girls.

- The educational qualifications of ATL in-charges affect the labs' effectiveness, highlighting the need for qualified personnel. The interrelation of strengths, weaknesses, opportunities, and challenges within ATLs is emphasized, with opportunities being created through innovative thinking and persistence. Successful ATL initiatives rely on the dedication and enthusiasm of in-charges, who often seek to enhance their skills for the benefit of their students.

- ATLs promote various learning methodologies, including game-based and project-based learning, while connecting theoretical knowledge to real-world applications. They prioritize understanding students' psychological needs by minimizing the pressure of quantitative assessments. The initiative focuses on cognitive, affective, and psychomotor domains, fostering a hands-on learning environment and introducing design thinking for innovative solutions. By recognizing achievements at various levels, ATLs aim to cultivate 21st-century skills and minimize challenges through a clear analysis of their strengths and opportunities.

- The role of ATL in-charges is pivotal as they act as change agents, fostering innovation and entrepreneurship among students. Their dedication to educational innovation has transformed ATLs into 21st-century knowledge hubs through active learning methodologies that engage a wide range of students. To maintain this transformation, continuous and structured practices are essential for creating sustainable knowledge hubs that empower students as lifelong learners and entrepreneurs.

- Student motivation is high, as evidenced by discussions revealing satisfaction with experiences in ATL. Key factors contributing to this include student clubs, collaborative learning, empathy-driven projects, tinkering-based learning, and real-world project work. Best practice schools have cultivated an engaging, student-driven ecosystem that promotes curiosity, confidence, and innovation.
- Assessment practices in these schools are well-structured, holistic, and skill-oriented, focusing on various dimensions such as practical work, projects, and presentations. Regular feedback and self-assessment help students monitor their progress and skills.
- Schools effectively showcase ATL events and projects, which not only inspire students but also enhance community engagement and recognition at national and global levels. This showcasing strategy has facilitated the acquisition of additional resources, sponsorships, mentorships, and partnerships for their ATLs.

7.3 MAJOR RECOMMENDATIONS

The National Education Policy (NEP) 2020 and the National Curriculum Framework for School Education (NCF) 2023 emphasize holistic education through experiential learning, skill development, and building 21st century skills in school students. To align Atal Tinkering Labs (ATLs) with these policies, their structure, pedagogy, and objectives can be redesigned to maximize interdisciplinary learning, entrepreneurial thinking, and technology-driven education. The following points may be considered:

Integration with Curriculum and Interdisciplinary Learning through ATL:

ATL activities should be integrated as part of the curriculum in schools and should not be treated as an extra activity. At present, in most schools, it is left to the choice of the students to participate in ATL activities or not. Teachers can effectively integrate the ATL activities into the existing curriculum through proper training. For this, there will be a need to strengthen ATL teacher training programs. This will remove the extra burden of ATL activities and ensure maximum participation of the students. Also, students may be encouraged to take up interdisciplinary projects through dedicated sessions allocated in the timetable. A National ATL Mentor Program can be taken up by the government to train students on various aspects of project making.

Transforming ATL to Knowledge and Innovation Hub:

ATL will be a major place of learning, innovation and skill development where students are involved in real world projects by collaborating with local businesses, farmers, hospitals, and NGOs. All projects should be based on a design-thinking approach to promoting innovation and centered on solving community problems. To convert ATL from a tinkering space to an incubation center for student startups, there will be a need for more Industry-Academia collaboration, following a research and development approach in executing all projects along with design-thinking integration, leveraging emerging technologies, fostering a culture of experimentation and establishing an ATL Alumni Network. There will also be a need to make ATL labs a part of National Education Policy (NEP) 2020's vocational education and skill development framework. The government will have to enhance financial grants for advanced ATL infrastructure (AI, IoT, AR/VR, biotech, etc.) and provide state and central government back-up funding to scale up successful student projects into startups. The government will also have to ensure each ATL has access to high-speed internet, cloud computing resources, and modern prototyping tools.

Emphasis on Building 21st Century Skills through ATL:

Training modules can be made to train teachers in developing 21st century skills such as creativity, collaboration, problem-solving, critical thinking, and communication skills in learners through ATL activities. Apart from developing practical skills in learners, socio-emotional skills can also be promoted through ATL. NEP 2020 emphasizes Socio-Emotional Learning (SEL) as a crucial component of holistic education. It recognizes that social and emotional skills are essential for students' overall development and success in life. ATL projects can include design thinking exercises, teamwork-based challenges, and community impact initiatives to enhance SEL. Encouraging students to work on social entrepreneurship projects can strengthen their empathy, resilience, and leadership skills.

Revenue Generation through ATL:

There is a need to identify potential ATL projects that can be converted into marketable products. ATLs need to partner with local businesses, e-commerce platforms, and startup incubators to sell student-designed products. ATL may be developed as a technology testing ground for industry innovations. The ATL Lab in future should contribute to India's economy. Aligning ATL projects with Make in India, Digital India, and Startup India can enhance their impact. India can aim to become a $500,000 trillion economy and ATLs can play a crucial role in building a strong foundation for innovation-driven growth.

More Autonomy to ATL:

To enhance the efficiency, sustainability, and impact of ATLs, granting them greater autonomy can lead to improved decision-making, flexibility, and innovation. First and foremost, ATLs should have the autonomy to design their own curriculum as per the needs of industry. This will improve the job prospects of the students. ATLs should have the flexibility to generate and utilize their own revenue from workshops, paid courses, and product commercialization. ATLs should be allowed to directly apply for government grants, CSR funding, and startup incubator funds. ATLs should independently partner with corporations, NGOs, and alumni networks for financial support. ATLs should be able to hire external experts, entrepreneurs, and researchers for advanced training sessions.

More inclusive and Equitable Education through ATL:

There is a need to promote more inclusive and equitable education through ATL. Tinkering corners may be set up in schools which lack the required space. Special programs for women entrepreneurs and girls in technology to bridge the gender gap in STEM. Separate programs like the ATL Girl Innovators Program which can provide dedicated mentorship, funding, and exposure for girls working in AI, robotics, and emerging technologies. ATL Women's Hackathons should be organized as a special competition for girls. Special scholarships should be introduced for girls to take up ATL activities. Special financial support may be provided for women-led student startups.

Promotion of Sustainability and Climate Resilient Engagement through ATL:

For a sustainable and self-reliant India and to achieve the vision of Viksit Bharat 2047, sustainability is no longer an option but a necessity for long-term economic growth, social well-being, and ecological balance. There will be a need to encourage eco-friendly projects that focus on sustainability, renewable energy, and environmental conservation, aligning with global goals for sustainable development. Students should be encouraged to develop solutions for waste management, renewable energy, and water conservation. Special competitions like Eco-Hackathons may be organized for students, and they should be trained on sustainable product design and green entrepreneurship towards a climate-resilient economy. The importance of resource management and innovation in creating sustainable should be one of the key areas of the ATL curriculum.

Assessment and Feedback Mechanisms from the ATL journey:

To maximize the impact of Atal Tinkering Labs (ATL), schools need structured assessment and feedback mechanisms that evaluate creativity, problem-solving, and hands-on skills of the students participating in ATL activities. A mechanism should be developed to track student growth in problem-solving, critical thinking, and entrepreneurship. Peer evaluation may also be considered to encourage students to evaluate each other's projects. Entrepreneurs, engineers, and academicians in the field may be invited for reviews. Teachers should be encouraged to use structured rubrics to evaluate creativity, sustainability, and technical implementation. Schools should organize regular exhibitions for students to present innovations. Every ATL should be encouraged to use social media to get inputs on projects. Option of using ATL digital portfolios to track student progress should also be considered. It is also important to track how ATL students pursue STEM careers and startups. For this a feedback mechanism may be developed by schools to collect data and insights from passed out students who have used the lab. The effectiveness of ATL in building 21st-century skills should be measured through research projects in this area.

REFERENCES

JOURNAL

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science. American educational research journal, 49(5), 881-908.

Arendt, K. M. (2024). Unleashing Entrepreneurial Education: Developing Entrepreneurial Mindsets, Competencies, and Long-Term Behavior. Copenhagen Business School [Phd]. PhD Series No. 03.2024 https://doi.org/10.22439/phd.03.2024

Birgit Schaffar & Lili-Ann Wolff (2024) Phenomenon-based learning in Finland: a critical overview of its historical and philosophical roots, Cogent Education, 11:1, 2309733, DOI: 10.1080/2331186X.2024.2309733

Blikstein, P. (2013). Digital fabrication and 'making'in education. FabLab: Of machines, makers, and inventors, 203-222.

Gershenfeld, N. A. (2005). Fab: The coming revolution on your desktop: From personal computers to personal fabrication. Basic Books (AZ).

Goldin, C., & Katz, L. F. (2010, November). The career cost of family. In Sloan Conference on Workforce Flexibility. Washington, DC.

Khanna, T. (2022). Science-based Entrepreneurship in India: A Policy Glass (as yet) Quarter-Full.

Kumar, R., & Sharma, P. (2021). Innovation and Design Thinking in NEP 2020: A Step Towards Future Learning. Journal of Educational Research.

Luckin, R. (2018). Enhancing Learning and Teaching with Technology: What the Research Says. UCL IOE Press. UCL Institute of Education, University of London, 20 Bedford Way, London WC1H 0AL.

Meymand, F. H. (2013). Evaluating the strengths, weaknesses, opportunities and threats of the strategic planning in educational organization of Kerman. European Online Journal Of Natural And Social Sciences, 1006-1011.

Mishra, S. (2021). Pedagogical Innovations and Teacher Training in NEP 2020. Indian Journal of Education and Development.

Mishra, S. and Gupta, S. (2023), Atal Tinkering Labs and the Global Notion of STEM Education, Shodh Sari-An International Multidisciplinary Journal, Vol. 02, Issue 04, 131-137, DOI: https://doi.org/10.59231/SARI7629

Mukherjee, M. Maity, C., Bhadra, M., Chatterjee, S. (2025). Towards Mainstreaming Work-Integrated Learning at the Secondary Level: A Pedagogical Framework of Learning Design. Work Integrated Learning-Direction for the Future Edited by Krishnamurthy Bindumadhavan, K. and Lacey, N. . SPRINGER, ISBN: 978-981-96-0200-1

Schleicher, A. (2019). PISA 2018: Insights and interpretations. OECD Publishing.

Sharath Kumar C.R, and P. K. (2023). SWOT ANALYSIS. International Journal of Advanced Research (IJAR), 744-748.

Sharma A., & Patel, V. (2022). Coding and Computational Thinking in Indian Schools Post. NEP 2020. Educational Technology Review.

Tan, A. L., Koh, D. J. Q., & Lim, X. Y. (2021). Science teacher education in Singapore: Developing twenty-first-century readiness. Singapore Math and Science Education Innovation: Beyond PISA, 227-240.

Vasudevan, A., & Ray, P. (2023). Macroeconomic Policies for Emerging and Developing Economies. Routledge India.

Vyas, A., Atal Tinkering Labs (2024). Promoting STEM Education in India and its challenges, Journal of Emerging Technologies and Innovative Research, Volume 11, Issue 9.

Wals, A. E., Weakland, J., & Corcoran, P. B. (2017). Preparing for the Ecocene: Envisioning futures for environmental and sustainability education. Japanese Journal of Environmental Education, 26(4), 4_71-76.

WEBSITES and OTHER SOURCES

A, B. (n.d.). shiksha STUDY ABROAD. Retrieved from shiksha.com: https://www.shiksha.com/studyabroad/stem-education-an-overview-articlepage-2661

ahmedabadmirror.com

ASER. (2019). Annual Status of Education Report-2018 (Rural). ASER, New Delhi, India.

https://img.asercentre.org/docs/ASER%202019/ASER2019%20report%20/aserreport2019earlyyearsfinal.pdf

Atal Innovation Mission. (n.d.). Atal Innovation Mission, NITI Aayog, Government of India. Retrieved March 15, 2025, from https://aim.gov.in

ATAL Innovation Mission (n.d.) : https://aim.gov.in/pdf/Introduction_to_Atal_Tinkering_Lab.pdf

British Council (n.d.). Innovation nation: entrepreneurial learning in Israel. https://www.britishcouncil.org/education/skills-employability/tool-resources/vocational-education-exchange/embedding-enterprise-entrepreneurship/innovation-nation-entrepreneurial-learning-israel

bwpeople.in

Compendium: Education Policies and Programmes in G20 Countries (2023). https://g7g20-documents.org/fileadmin/G7G20_documents/2023/G20/India/Sherpa-Track/Education%20Ministers/3%20Miscellaneous/Compendium%20Education%20Policies%20and%20Programmes%20in%20G20%20Countries_22062023.pdf

Economic Times

egc.yale.edu

en.wikipedia.org

gomantaktimes.com

GTAI (2019).Report: More Jobs Created. https://www.gtai.de/en/invest/business-location-germany/foreign-direct-investment/germany-trade-invest-fdi-reports-770290#785240

http://aim.gov.in/pdf/ATL-Equipment-Batch-of-60.pdf

http://aim.gov.in/pdf/ATL-Equipment-Batch-of-90.pdf

https://www.stemrobo.com/atal-tinkering-lab/

https://www.stemrobo.com/atal-tinkering-lab-a-catalyst-for-innovation-in-schools/

Indiastat

indiatoday.in

Jogeshwar, R. (n.d.). DD NEWS. Retrieved from https://ddnews.gov.in/en/shaping-viksit-bharat-50000-atal-tinkering-labs-to-drive-innovation/

LEARNING Lesson from 52 countries, Volume One. Edited by Mukhopadhya, Kaibarta, Gantait and Mukherjee. ETMA, Gurugram-122003, Faridabad Road, Haryana, India.ISBN 978-81-969998-5-8

linkedin.com

livemint.com

MHRD, (1992). National Policy on Education-1986: Programme of Action (1992), Department of Education Government of India. Retrieved December 28, 2019 from https://mhrd.gov.in/sites/upload_files/mhrd/files/upload_document/npe.pdf

MHRD, (1992). National Policy on Education-1986: Programme of Action (1992), Department of Education Government of India. Retrieved December 28, 2019 from https://mhrd.gov.in/sites/upload_files/mhrd/files/upload_document/npe.pdf

MHRD. (2016). Some Inputs for Draft National Education Policy-2016. Retrieved December 28, 2019 from https://mhrd.gov.in/sites/upload_files/mhrd/files/nep/Inputs_Draft_NEP_2016.pdf

MHRD. (1986). National Policy on Education. Department of Education, Government of India. Retrieved December 28, 2019 from http://www.ncert.nic.in/oth_anoun/policy_1986_eng.pdf

MHRD. (1986). National Policy on Education. Department of Education, Government of India. Retrieved December 28, 2019 from http://www.ncert.nic.in/oth_anoun/policy_1986_eng.pdf

MHRD. (2019). Draft: National Education Policy. Government of India. Retrieved December 28, 2019 from https://mhrd.gov.in/sites/upload_files/mhrd/files/Draft_NEP_2019_EN_Revised.pdf

Ministry of Education (MoE) , GOI, National Educational Policy, 2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Ministry of Education, Government of India. (2023). National curriculum framework for school education 2023. https://ncf.ncert.gov.in

Ministry of Education, Government of India. (2020). National Education Policy 2020.https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Ministry of Education, Government of India. (2020). National Education Policy 2020. MHRD, Government of India. https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Ministry of Education, Government of India. (2020). National Education Policy 2020. MHRD,

Government of India. https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

NABARD

NAS. (2018). National Achievement Survey-2018. Retrieved December 28, 2019 from http://www.ncert.nic.in/programmes/NAS/NAS.html

NAS. (2018). National Achievement Survey-2018. Retrieved December 28, 2019 from http://www.ncert.nic.in/programmes/NAS/NAS.html

NCERT. (2005). National curriculum framework 2005. National Council of Educational Research and Training. New Delhi. Retrieved December 28, 2019 from http://www.ncert.nic.in/rightside/links/pdf/framework/prelims.pdf

NCTE. (2010). National Curriculum Framework for Teacher Education: Towards Preparing Professionaland Humane Teache. NCTE, New Delhi, India. Retrieved December 28, 2019 from https://ncte.gov.in/Website/PDF/NCFTE_2009.pdf

OECD (2019). FUTURE OF EDUCATION AND SKILLS 2030 OECD Learning Compass 2030. A SERIES OF CONCEPT NOTES. https://www.oecd.org/content/dam/oecd/en/about/projects/edu/education-2040/1-1-learning-compass/OECD_Learning_Compass_2030_Concept_Note_Series.pdf

pib.gov.in

publications.anveshanaindia.com

researchgate.net

SAS Publishers

timesofindia.indiatimes.com)

ANNEXURES

ANNEXURE A: Students' feedback on uses of ATL

ANNEXURE B: Students achievement test

ANNEXURE C: A creative design thinking scale was administered to collect the data andthe five-point questionnaire used for expressing the entrepreneurship skills.

ANNEXURE D: Scheduled type questionnaire administered to the ATL in-charge

ANNEXURE E: Interview schedule used to explore the SWOC

ANNEXURE F: Teaching learning in ATL

ANNEXURE G: Lab observation schedule

ANNEXURE H: Illustrative list of equipments in ATL

ANNEXURE I: Workshops conducted for the research project

ANNEXURE - A

TOOL no. 1

For Students

To study the status of the use of ATL in Secondary Schools of the Western Region in India

Questionnaire for Data Collection

Section A: Demographic Information

Name of theSchool:_____

Location (City, District,State):_____

Areas (Metropolitan/ Urban /Semi-Urban/Rural):_____

Respondent's Role, Student: _____

Nature of the management (Public School/Private School/ Minority Institution):_____

Class/Grade:_____

Age:_____

Gender:_____

Section B: Student feedback regarding usage of ATL

1. How often do you use the ATL facilities?
   - Daily
   - Weekly
   - Monthly
   - Rarely
2. What activities do you participate in at the ATL? (Select all that apply)
   - Robotics
   - 3D Printing
   - Electronics
   - Coding/Programming
3. How long have you been engaged with the ATL project?
   - 1 to 2 years
   - 2 to 3 years
   - 3 to 4 years
   - More than 4 years
4. Rate your interest in activities conducted at the ATL
   - Very High

- High
- Moderate
- Low

5. What motivates you to participate in ATL activities? (Select all that apply)
   - Interest in Science and Technology
   - Desire to Learn New Skills
   - Encouragement from Teachers
   - Influence of Peers
6. How often do you participate in ATL workshops?
   - Always
   - Often
   - Seldom
   - Never
7. Which ATL resources do you find most useful? (Select all that apply)
   - Robotics Kits
   - 3D Printers
   - Electronics Components
   - Computers and Software
8. How accessible is the ATL for students outside of regular school hours?
   - Always
   - Occasionally
   - Rarely
   - Never
9. Do you receive guidance from ATL in-charge while working in the ATL?
   - Always
   - Often
   - Rarely
   - Never
10. How would you like to rate the effectiveness of the quality of facilitation of the MOCs?
    - Excellent
    - Good
    - Average
    - Poor
11. Do you have enough opportunity to collaborate with peers on projects in the ATL?
    - Always
    - Often
    - Sometimes
    - Rarely
12. How has your participation in ATL activities influenced your interest in pursuing careers in STEM (-Science -Technology -Engineering -Mathematics)?
    - Significantly Increased
    - Moderately Increased
    - Slightly Increased
    - Insignificant

13. Have you been involved in any competitions through your ATL?
    (Tick whichever is applicable)

ATL Led

ATL Hackathon	Yes	No
ATL Marathon	Yes	No
ATL Tinkerpreneur	Yes	No
ATL Ideathon	Yes	No

what was your experience in these competitions?

_____

14. What types of projects have you completed using ATL resources? (Open-ended)

    _____
    _____
    _____

ANNEXURE - B

**AchievementTestQuestionnaire(कृ◆◆त्वपर◆◆◆

BASICINFORMATION/बु◆◆याद◆◆नकार◆◆

StudentName/ छात्रकानाम:_____

_____**Sc**

hoolName/ स्कूलकानाम:_____

_____**Cl**

ass/ क◆◆ा:_____

_____**N**

ameofYourATLIn-Charge/ आपकेATLइंचाजर्कानाम:_____

_____**N**

ameofYourAIMMentorofChange/ आपकेAIMम◆◆ऑफच◆◆कानाम:

_____**D**

ate/ ◆दनांक:_____

Questions/प्रश्न

1. Whatisdatavisualization?/डेटाfवज़ुअलाइज़ेशनक्याहै?
   a) Theprocessofcollectingdatathroughsurveys/सर्वे�णकेमाध्यमसेडेटाएकत्रकरनेक�fक्रया।
   b) Theactofrepresentingdatainavisualformatlikechartsorgraphs/डेटाकोचार्ट्यागाफजैसेदृश्यप्रारूपम�प्रस्तुतकरनेक�fक्रया।
   c) Organizingdataintables/डेटाकोताfलकाओं�मविस्थतकरना।
   d) Analysingdatatofindpatterns/पैट्खोजनेकेfलएडेटाकाfवश्लेषणकरना।

2. Studentscollecteddataontheirclassmates' favouritehobbies. Howdochartsandgraphs helpthemunderstandthisdata?/छात्र�नेअपनेसहपाfठय़केपसंदkदाशौक़ परडेटाएकया।चार्टऔरग्राफउन्हेंसडेटाकोसमझनेम�कैसेमददकरतेहै?
   a) Visualizepatternsandtrendsinhobbypreferences/शौककेप्राथfमकताओंम�पैटर्नऔरट्रेन्डकादृश्यकरणकरना।
   b) Makethedatamoredifficulttointerpret/डेटाकोव्याख्याकरनेम�औरअfधकचुनौतीपूर्णबनाना।
   c) Facilitatecomparisonsbetweendifferenthobbies/fवfभन्नशौक़ केबीचतुलनाक सुविधाप्रदानकरना।
   d) Replacetheneedtolookattheoriginaldata/मूलडेटाकोदेखनेक आवश्यकताकोसमाप्तकरना।

3. Inthecontextofhealthcare, howcandatavisualizationbeleveragedtoimprovepatient care?/स्वास्थ्यसेवाकेसंदर्भम डेटाfवज़ुअलाइज़ेशनकाउपयोगरोगीदेखभालम सुधारकेfलएकैसेfकयाजासकताहै?
   a) Bycreatingvisuallyappealingmedicalreportsforpatients/रोfगय़केfलएदृश्यरूपसेआकर्षकfचfकत्सारिपोर्टबनाकर।
   b) Bytrackinganddisplayingpatientvitalsignsinreal−timetoenablequickdecision−making/रोगीकेमहत्वपूर्णसंकेत�कोवास्तfवकसमयम ट्रैकऔरप्रदर्शकरकेत्व�रतनिर्णलेनेम सक्षम बनाना।
   c) Bygeneratingcolourfulinfographicsaboutdifferentdiseases/fवfभन्नरोग़ केबारेंम रंगीनइन्फोग्राfफक्सबनाकर।
   d) Byorganizingpatientdatainalphabeticalorderforeasyaccess/आसानपहुँचकेलिरोगीडेटाकोवर्णमालाक्रमम�विस्थतकरके।

4. Anenvironmentalistisstudyingtheimpactofclimatechangeonthepopulationofaparticularspeciesoverseveraldecades. Whichcharttypewouldbestillustratethistrend?/एकपर्यावरणfवद्कईदशक़ोंकfवशेषप्रजाfतक़ जनसंख्यापरजलवायुप़रिवर्तनके

प्रभावकाअध्ययनकररहाहै।इसप्रवृf◌ृकोकौन-साचार्ट्प्रकारसबसेअच्छेतौरपरदर्शाएगा?

a) Piechart/पाईचार्ट

b) Bargraph/बारग्राफ

c) Scatterplot/स्कैटरप्लॉट

d) Linegraph/लाइनग्राफ

5. **Assertion(A):**Apiechartisthebestvisualizationtooltorepresentthepercentage distributionofdifferenttypesofrenewableenergysourcesusedinacountry. /

कथन(A):पाईचार्ट्एकदेशमें◌ंप्रयोगfकएजानेवालेfवfभिन्नप्रकारकेनवीकरणीयऊर्जास्रो◌ंकेप्रfतशतfवतरणकाप्रfतfनfधित्वकरनेकासबसेअच्छादृश्यउपकरणहै।)

Reason(R): Apiechartteffectivelyshowstherelativeproportionsofvariouscategorieswithinawhole. /

कारण(R):पाईचार्ट्fकसीसंपूर्णवस्तुकेभीतरfवfभिन्नश्रेfणय◌ंकेसापे◌ंअनुपातकोप्रभावीढंग सेदर्शातीहै।*(A)*

a) BothAssertion(A) andReason(R) aretruebutReason(R) isnotthecorrectexplanationforAssertion(A) /दोन◌ंकथन(A)औरकारण(R)सहkह◌ं,लेfकनकारण(R) कथनक◌ंसहkव्याख्यानहk◌ंहै।

b) BothAssertion(A) andReason(R) aretrueandReason(R) isthecorrectexplanationforAssertion(A) /दोन◌ंकथन (A)औरकारण (R) सहk◌ंऔरकारण (R) कथनक◌ंसहkव्याख्याहै।

c) Assertion(A) istruebutReason(R) isfalse/ कथन(A)सहkहै,लेfकनकारण(R)गलतहै।

d) Assertion(A) isfalsebutReason(R) istrue/कथन(A)गलतहै,लेfकनकारण(R)सहीहै।

6. WhichcharttypefromTable2wouldbemostsuitabletovisualizethedatainTable1? /तfलका2सेकौनसाचार्ट्प्रकारतfलका1केडेटाकोदृश्यरूपम◌ंप्रस्तुतकरनेकेलिएसबसेउपयुक्तहोगा?

a) A

b) B

c) C

d) D

Table1/तालिका1

MobilePhoneType/ मोबाइलफोनकेप्रकार	NumberofUnitsSold/ ◆क◆ ◆ ◆◆ईइकाइय◆ ◆◆ंख्या
Smartphone/ स्मार्टफोन	50
MobilePhoneType/ मोबाइलफोनकेप्रकार	NumberofUnitsSold/ ◆क◆ ◆ ◆◆ईइकाइय◆ ◆◆ंख्या
FeaturePhone/ फ़◆चर फोन	20
BasicPhone/ साधार णफोन	10

*Table2/*ताfलका*2*

ChartType/ चाट्प्रकार	BestSuitedFor/◆◆सकेके ◆◆एसबसेउपयुक्त
A.PieChart/ पाईचाटर्	Showingpartsofawhole/fकसीसंपूण्क्रेभागfदखानेके fलए
B.BarGraph/ बारग्राफ	Comparingdifferentcategories/fवfभन्नश्रेfणय◆क◆तुलनाके fलए
C.LineGraph/लाइन ग्राफ	Showingtrendsovertime/समयकेसाथरुझानfदखानेके fलए
D.Scatterplot/ स्कैटर प्लॉट	Showingtherelationshipbetweentwovariables/दोचरके बीचसंबंधfदखानेकेfलए

7. Thedimensionsofworkplanefor3-DdesigninginTinkerCadsoftwareisTinkerCad/ सॉफ़्टवेयर◆Dfडज़ाइfनंगकेfलएक्लेनकाआयामक्याहै?

   a) 10cmx10cm/10सेमीx10सेमी
   b) 20mmx20mm/20fममीx20fममी
   c) 200mmx200mm/200fममीx200fममी
   d) 10cmx20cm/ 10सेमीx20सेमी

8. Identifytheincorrectoptionfromthefollowing:/fनम्न◆◆गलतfवकल्पक◆पहचानक◆

   a) Group:Ctrl+G/ग्रुप:Ctrl+G
   b) Ungroup:Ctrl+Shift+G/अनग्रुप:Ctrl+Shift+G

c) Align : L/एलाइन : L

d) Ungroup : Ctrl+Alt+G/अनग्रुप : Ctrl+Alt+G

9. Unitsof**Workplane**definedinworkspacesettingsin*TinkerCad*softwarecannotbein : / *TinkerCad*सॉफ़्टवेयरमें**वर्क प्लेन**क◆इकाइयाँ◆्सपेससेfटंग्स◆◆नम्नमें◆fकसम◆◆नहk◌ंहोसकतीं :

a) Millimetre/fमलkमीटर

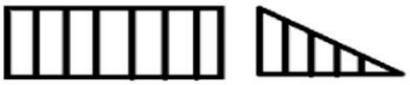
b) Centimetre/स◆टीमीटर

c) Bricks/fब्रक्स

d) Inches/इंच

10. Whichofthefollowingpatternwillbemergedunit : /fनम्नfलfखतम◆नेकौन-सापैट्◆fवलfयतइकाईहोगा:

a)

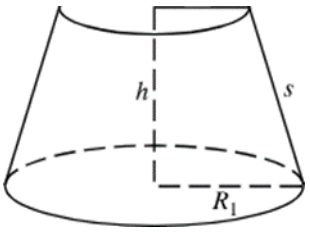


b)

c)

d)

11. FrustumofaconehavingR1as10cm, R2as5cm, slantheightas5cm, andheight3cm istobe3Dprintedthenforitsproperdesigningthebaseforthefrustumshouldbe consideredalong : /R110सेमी, R25सेमी, fतयर्कऊंचाई5सेमीऔरऊंचाई3सेमीवालेशंकुकेfछन्नकको3डीfप्रंटfकयाजानाहै, तोइसकेउfचतfडजाइनकेfल एfछन्नककाआधारfकसकेसाथfवचारfकयाजानाचाfहए:

1. 

a) Height/ऊँचाई

b) R2

c) SlantHeight/◆ऊँचाई

d) R1

12. Fromthefollowingoptions, choosethecorrectoption, whichislessconcernedin3 -D printing/fनम्नfलfखतfवकल्प◌ं◌मेंवहसहkfवकल्पचुन◌ं, जो3-डीfप्रंfटंगसेकमसंबंधहै:

a) Levelingofthebedof3-Dprinter/3-Dfप्रंटरकेबेडकास्तरसमायोजन

b) Loadingfilament/fफलाम◌ंटलोडकरना

c) Temperatureofbedof3-Dprinter/3-Dfप्रंटरकेबेडकातापमान

d) Coloroffilamentused/उपयोगfकएगएfफलाम◌ंटकारंग

13. FindtheproperorderfortheStepsofPrintingwitha3DPrinterfromthejumbled stepsgivenbelow-(नीचेfदयेगए 3Dfप्रंटरकेसाथfप्रंfटंगकेचरण◌ंकासहkक्रमलहै)?

A. SettheDesignforPrinting/ fप्रं◌ंगके◌ंलए◌ंडज़ाइनसेटक◌ं

B. ChoosingtheRight3DPrinter/सह◌ं3Dfप्रंटरकाचयन

C. BuildingtheObject/ वस्तुका◌ंनमार्ण

D. Choosinga3DSlicingSoftware/3Dस्लाइ◌ंसंगसॉफ़्टवेयरकाचयन

a) B-D-A-C

b) D-A-B-C

c) C-D-B-A

d) B-A-D-C

14. Whichelementofdesignthinkingwillalwaysbeconsideredin3-Dprinting? /3-Dfप्रंfटंग◌ंडजाइनfथंfकंगकाकौन-सेतत्वकाहमेशाध्यानरखाजाताहै?

a) Empathy/समानुभूfत

b) Ideate/fवचारकरना

c) Prototype/प्रोटोटाइप

d) Define/प◌ंरभाfषतक◌ं

15. Whatarethe5–stepsofdesignandentrepreneurialthinking? /fडज़ाइनऔरउद्यमशीलतासोचके 5चरणक्या◌ं

a) Introduction, conceptualize, sell, purchase, andadvertise/ प◌ंरचय, अवधारणा, बेचने, खरkदनेऔरfव◌ंज्ञापन

b) Empathize, Define, Ideate, Prototype, andTest/

समानुभूfत, प्रभाfषतकरना, fवचारकरना, प्रोटोटाइप, औरपरk्षण

c) Learning, discussions, demonstration, actualization, andcommercialization/ सीखना, चर्चाप्रदर्शन, वास्तfवकताऔरव्यावसायीकरण

d) Synchronising, assessing, summarising, exploring, andpresenting/
समक्रमण, मूल्यांकन, सारांश, अन्वेषण, औरप्रस्तुत

16. Whatdoyoumeanby'GOWIDE, GOBIG!'Intermsofentrepreneurialthinking?/
उद्यमशीलतासोचकेसंदर्भ'GOWIDE, GOBIG!'काक्यामतलबहै?

a) Followthecommonrules/सामान्यनियम◌ का पालन◌

b) Setyourgoalsaccordingtoothers/अपनेलक्ष्य◌ दूसर◌ के अनुसार◌

c) Don'tlimityourself/खुदकोसीमितन◌

d) Exploretheopportunitiesinotherfields/अन्य◌ क्ष◌ अवसर◌ कापतालगाएं

17. Whatisaprototype?/प्रोटोटाइपक्याहोताहै?

a) Finalproducttosell/बेचनेकेलिएअंतिमउत्पाद

b) Rawmaterial/कच्चामाल

c) Animalsname/जानवरकानाम

d) Originalmodelofdevelopedproduct/विकसितउत्पादकामूलमॉडल

18. WhatdoyoumeanbyEMPATHISEintermsofentrepreneurialthinking?/उद्यमशीलतासोचकेसंदर्भ◌ EMPATHISEका
क्यामतलबहै?

a) Understandtheusers/उपयोक्ताओंकोसमझना

b) Understandtheparents/माता-पिताकोसमझना

c) Understandthenationalrules/राष्ट्रीयनियम◌ कोसमझना

d) Understandstheproduct/उत्पादकोसमझना

19. Mostimportantpartofyourentrepreneurialthinkingwillbe?/आपक◌ उद्यमशीलतासंबंधीसोचकासबसेमहत्वपूर्णहिस्साक्याहोगा?

a) Packagingandcolour/पैकेजिंगऔररंग

b) AffordabilityandEfficiency/सामर्थ्यऔरद◌ ता

c) PhysicalappearanceandPrice/भौतिकबनावटऔरक◌ मत

d) AvailabilityandPackaging/उपलब्धताऔरपैकेजिंग

20. Finalgoalofanyprototypeorservicesshouldbe?/fकसीभीप्रोटोटाइपयासेवाओंकाअंfतमलāयक्याहोनाचाfहए?

a) Commercialization/व्यावसायीकरण

b) Addressingthesocialproblem/सामाजिकसमस्याकासमाधानकरना

c) Availabilityofrawmaterialincheaperrates/कच्चेमालक◌ सस्तीदर◌ पउपलब्धता

d) Marketcapturing/बाजारपरकब्जा

21. Whatdoyoumeanbysustainablebusinesspractices?/सततव्यावसाfयकप्रथाओंकाक्यामतलबहै?

a) Meetingthemarketdemand/बाजारक◌मांगकोपूराकरना

b) Customersatisfaction/ग्राहकसंतुष्टि

c) Eco-friendlycommercialization/पयार्वरणकेअनुकूलव्यावसायीकरण

d) Low-costproducts/कमलागतवालेउत्पाद

22. Entrepreneurialthinkingprocessmustinclude?/उद्यमशीलतासोचप्रfक्रयामें◌ाशाfमलहोनाचाfहए?

a) Innovativeness/नवाचार

b) Manufacturing/fनमार्ण

c) Packaging/पैकेजिंग

d) Rawmaterialavailability/कच्चेमालक◌उपलब्धता

23. Whichoneisanexampleofanentrepreneurialventure?/उद्यमशीलउद्यमकाएकउदाहरणकौन-साहै?

a) TraditionalBusiness/पारंप◌रकव्यवसाय

b) Marketingofproductswithauniquemediumofdistribution/fवतरणकेअनूठेमाध्यमकेसाथउत्पाद
◌काfवपणन

c) TraditionalManufacturing/पारंप◌रकfनमार्ण

d) CottonProcessing/कपासप्रसंस्करण

24. Whichtypeofconnectioniscommonlyusedfordomesticappliancessimultaneouslylikebulbs, tubelights, fans, ACsinyourAtalTinkeringLab (ATL) forgivingthempower supply?/आपकेअटलfटंक◌रंगलैब (ATL) म◌ेकसाथfबजलkअपूह्केfलएबल्ब, ट्यूब लाइट, पंखे, ACजैसेघरेलूउपकरण◌केfलएfकसप्रकारकाकनेक्शनआमतौरपरइ◌ोगकयाजाताहै?

a) Seriesconnection/श्रृंखलाकनेक्शन

b) Parallelconnection/समानांतरकनेक्शन

c) BothSeriesandParallelconnection/दोन◌ृंखलाऔरसमानांतरकनेक्शन

d) SeriesorParallelconnectionasrequiredbytheappliancesmentioned/

ठिल्लfखतउपकरण◆केअनुसारश्रृंखलायासमानांतरकनेक्शन

25. Whatisthestandardvoltageusedfor3-DPrinterinyourAtalTinkeringLab(ATL)?

/आपकेअटलfटंक◆रंगलैब(ATL)म◆3-Dfप्रिंटरकेfलएमानकवोल्टेजक्याहै?

a) 110Volt/110वोल्ट

b) 220Volt/220वोल्ट

c) 440Volt/440वोल्ट

d) 12Volt/12वोल्ट

26. Youarebuildingasmartlampthatautomaticallyturnsonwhenitgetsdark.

Whichsensorwillyouusetodetecttheambientlightlevels?/आपएकस्मार्टल◆◆नारहे◆◆◆अंधेराहोनेपरस्वचाfलतरूपसेचालूहोजाताहै।प

◆रवेशीयप्रकाशस्तर◆कापतालगानेकेfलएआपfकससे◆सरकाउपयोगकर◆गे?

a) TemperatureSensor/तापमानस◆सर

b) UltrasonicSensor/अल्ट्रासोfनकस◆सर

c) LDR/एल. डी. आर.

d) GasSensor/गैससस◆सर

27. Tocreatealine-

followingrobotwithArduinoUno, whichtypeofsensorshouldbeusedtodetectthelineonthefloor?/Arduin

oUnoकेसाथलाइन-फॉलोइंगरोबोटबनानेके◆◆रलाइनकापतालगानेकेfलएfकसप्रकारकेस◆सरकाउपयोगfकयाजानाचाfहए?

a) UltrasonicSensor/अल्ट्रासोfनकस◆सर

b) LDRSensor/एल. डी. आर. स◆सर

c) IR(Infrared)Sensor/आई. आर. (इन्फ्रारेड)स◆◆र

d) TemperatureSensor/तापमानस◆सर

28. WhichpowersourceisNOTrecommendedfordirectlypoweringtheArduinoUno?/

ArduinoUnoकोसीधेपावरदेनेकेfलएfकसपावरस्रोतक◆अनुशंसानहk◌ंक◆जातीहै?

a) 5Vpowersupply/5Vपावरसप्लाई

b) USBconnectionfromacomputer/कंप्यूटरसेयू. एस. बी. कनेक्शन

c) 9Vbattery/9Vबैटरk

d) 12VBattery/12Vबैटरk

29. Whatdoesthe“digitalWrite(13, HIGH);”commanddoinArduino?/Arduinoम“digitalWrite(13, HIGH);”कमांडक्याकरताहै?

a) TurnsofftheLEDonpin13/fपन13परएल. ई. डी. कोबंदकरताहै।

b) TurnsontheLEDonpin13/fपन13परएल. ई. डी. कोचालूकरताहै।

c) BlinkstheLEDonpin13/fपन13परएल. ई. डी. कोझपकाताहै।

d) ChangestheLEDcolor/एल. ई. डी. कारंगबदलताहै।

30. IfyouwanttomaketheArduinowaitfor1second, whichcommandwouldyouuse?/यfदआपArduinoको1सेकंडकेfलएप्रती[illegible]कानाचाहतेहोआपकौन-सेकमांडकाप्रयोगकर[illegible]गे?

a) delay(1);

b) wait(1);

c) delay(1000);

d) pause(1000);

31. WhatisuseofTinkercadsoftwareinyourAtalTinkeringLab(ATL)?/आपकेअटलfटंक[illegible]रंगलैब(ATL)म[illegible]Tinkercadसॉफ़्टवेयरकाक्याउपयोगहै?

a) Drawingpictures/fचत्रबनाना

b) Buildingcircuitsand3-Dmodels/[illegible]और3-Dमॉडलबनाना

c) Writingstories/कहाfनयाँfलखना

d) Playinggames/खेलखेलना

32. HowdoyoudeleteacomponentinTinkercadCircuitssoftware?/आपTinkercadCircuitsसॉफ़्टवेयरम[illegible]कघटककोकैसेहटातेह[illegible]?

a) Clickonthecomponentandpressthe Deletekey/घटकपरिक्लकक[illegible]और fडलkटकंुजीदबाएं

b) Double-clickonthecomponent/घटकपरडबल-ि्लकक[illegible]

c) Right-clickandselect"Erase"/दाएं-ि्लकक[illegible]और"Erase"चुन[illegible]

d) Dragthecomponentoffthescreen/घटककोस्क्र[illegible]नसेबाहरखींच[illegible]

33. Afactoryusesroboticgripperstohandledelicateelectroniccomponents. Whichlever typeshouldbeusedtoensureminimalforceisapplied?

/एकफैक्ट्रkम्मेंाजुकइलेक्ट्रॉfनकघटक◌कोसंभालनेकेfलएरोबोfटकfग्रपरकाउपयोगfकयाजाताहै।सुfनिश्चतकरनेकेfलएकिसप्रकारकाउ◌ोलकइस्तेमालfकयाजानाचाfहएfकन्यूनतमबललगायाजाए?

A) First-classlever/प्रथमश्रेणीकाउ◌ोलक

B) Second-classlever/द्वितीयश्रेणीकाउ◌ोलक

C) Third-classlever/तृतीयश्रेणीकाउ◌ोलक

D) Fourth-classlever/चतुर्थश्रेणीकाउ◌ोलक

34. Ifaroboticgripper's leverarmislengthened, whateffectwillithaveontheforce requiredtoliftanobject?/यदिएकरोबोटिकग्रिपरकेउ◌ोलकभुजाकोलंबाकियाजाए, तोवस्तुउठानेकेलिएआवश्यकबलपरक्याप्रभावपड़ेगा?

A) ForceIncreases/बलमें◌ृद्धिहोगी

B) ForceDecreases/बलमें◌ीहोगी

C) NochangeintheForce/बलम◌ेकोईप◌रवर्तननहीं◌ंहोगा

D) ForceBecomeszero/बलशून्यहोजाएगा

35. Inarescueoperation, howwouldyoumodifyaroboticgrippertosafelyliftachild fromdebris?/एकबचावअभियानम◌ेंमलबेसेबच्चेकोसुरक्षितरूपसेउठानेकेलिएआपरोबोटिकग्रिपरकोकैसेसंशोधितकर◌ेंगे?

A) Increasetheleverarmlength/उ◌ोलकभुजाक◌ेलंबाईबढ़ाएँ

B) Decreasetheleverarmlength/उ◌ोलकभुजाक◌ेलंबाईघटाएँ

C) Useashorterfulcrum/छोटेआधारबिंदुकाउपयोगक◌ें

D) Useastrongermaterial/मजबूतसामग्रीकाउपयोगक◌ें

36. Whichadjustmentwillallowawastecollectionmechanismtoliftheavierdebriswithoutdamagingitself?/किसस मायोजनसेकचरासंग्रहणतंत्रकोस्वयंकोनुकसानपहुँचाएबिनाभारीमलबाउठानेक◌ेअनुमतिमलेगी?

A) Strengthentheleverarm/उ◌ोलकभुजाकोमजबूतक◌ें

B) Uselightermaterials/हल्क◌ेसामग्रीकाउपयोगक◌ें

C) Increasethespeedofoperation/संचालनक◌ेगतिबढ़ाएँ

D) Lowerthefulcrumpoint/आधारबिंदुकोनीचाक◌ें

37. Inaprostheticarmusedforliftinggroceries, howdoesadjustingthelengthofthelever armaffectitsefficiency?

/किसीकृत्रिमभुजा◌ोंकाउ◌ोलकभुजाक◌ेलंबाईकोसमायोजितकरनेसेइसक◌ेद◌ंतापरक्याप्रभावपड़ताहै?

A) Itincreasesefficiency/यहदक्षताकोबढ़ाताहै

B) Itdecreasesefficiency/यहद◆ताकोघटाताहै

C) Itmakesnodifference/इसकाकोईफ़र्कनहींपड़ता

D) Itreversesthemotion/यहगतिकोउलटदेताहै

38. Aroboticgripperisbeingusedinafactorytoplacecomponentsonaconveyorbelt. Howwouldshiftingthefulcrumclosertotheloadaffecttheforcerequired?/एकरोबोटिकग्रिपरकाउपयोगफैक्ट्रीमेंएककन्वेयरबेल्टपरघटकोंकोरखनेकेलिएकियाजाताहै।भारकेकरीबआधारबिंदुकोस्थानांतरितकरनेसेआवश्यकबलपरक्याप्रभावपड़ेगा?

A) Increaseforcerequired/आवश्यकबलबढ़ेगा

B) Decreaseforcerequired/आवश्यकबलकमहोगी

C) Nochangeinforce/बलमेंकोईपरिवर्तननहींहोगा

D) Doubletheforce/बलकोदोगुनाकरदेगा

39. Whatisthemainadvantageofusingfluidsinhydraulicsystems?/हाइड्रोलिकप्रणालियोंमेंतरलपदार्थोंकाउपयोगकरनेकामुख्यलाभ क्याहै

A) Highdensity/उच्चघनत्व

B) Abilitytocompress/संपीड़नक्षमता

C) Abilitytotransmitforceeasily/बलकोआसानीसेस्थानांतरितकरनेकक्षमता

D) Highboilingpoint/उच्चक्वथनांक

40. Howdoesincreasingthesurfaceareaofthepistoninahydraulicliftaffectthelifting capacity?/हाइड्रोलिकलिफ्टमेंपिस्टनकेसतहक्षेत्रकोबढ़ानेसेउठानेकक्षमतापरक्याप्रभावपड़ताहै?

A) Increasesliftingcapacity/उठानेकक्षमताबढ़तीहै

B) Decreasesliftingcapacity/उठानेकक्षमताघटतीहै

C) Noeffect/कोईप्रभावनहींपड़ता

D) Reversesliftingdirection/उठानेकीदिशाउलटजातीहै

41. Whymightaconstructionsitepreferahydraulicliftoveramechanicalpulleysystem?/ एकनिर्माणस्थलपरयांत्रिकचरखीप्रणालीकेतुलनामेंहाइड्रोलिकलिफ्टकोक्योंप्राथमिकताद्दीजासकतीहै?

A) Easiertomaintain/बनाएरखनेमेंआसान

B) Higherliftingspeed/उच्चउठानेक◆गfत

C) Requireslessmanualeffort/कमशारीरकप्रयासकीआवश्यकताहोतीहै

D) Morecompactdesign/अधिकसंघनडिजाइन

42. Aconstructionengineerwantstomodifyahydrauliclifttohandleheavierloads. What isthemosteffectivemodification?/एकनिर्माणइंजीनियरहाइड्रोलिकलिफ्टकोभारीभारसंभालनेकेलिएसंशोधितकरनाचाहताहै।सबसेप्रभावीसंशोधन क्याहै?

A) Increasepistonsurfacearea/पिस्टनकीसतहक्षेत्रकोबढ़ाएँ

B) Usealighterfluid/हल्केतरलकाउपयोगकरें

C) Decreasepistonsurfacearea/पिस्टनकीसतहक्षेत्रकोघटाएँ

D) Increasefluidviscosity/तरलश्यानताबढ़ाएँ

43. WhatistheprimaryroleofsensorsintheBugbot? /बगबॉटमेंसेंसरकीप्राथमिकभूमिकाक्याहै?

A) Togeneratepower/बिजलीउत्पन्नकरना

B) Todetectobstaclesandrespondtotheenvironment/वातावरणमेंबाधाओंकापतालगानाऔरवातावरणपरप्रतिक्रियाकरना

C) Tocontrolthespeed/गतिकोनियंत्रितकरना

D) Tostoreenergy/ऊर्जाकोसंग्रहितकरना

44. HowdoestheuseofmotorsinBugbotaidinitsmovement? /बगबॉटमेंमोटरकाउपयोगइसकी गतिमेंकैसेमददकरताहै?

A) Byprovidingrotationalforce/घूर्णनबलप्रदानकरके

B) Bygeneratingheat/गर्मीउत्पन्नकरके

C) Bysensingobstacles/बाधाओंकापतालगाकर

D) Bystoringelectricalenergy/विद्युतऊर्जाकोसंग्रहीतकरके

45. IfaBugbotistobeusedinasearch−and−rescueoperation, whatmodificationcould enhanceitsfunctionality?/यदिबगबॉटकाउपयोगखोजऔरबचावअभियानकेलियाजानाहै, तोकौनसासंशोधनइसकीकार्यक्षमताकोबढ़ासकताहै?

A) Addingthermalimagingsensors/थर्मलइमेजिंगसेंसरजोड़ना

B) Increasingbatterysize/बैटरीकाआकारबढ़ाना

C) Addingdecorativelights/सजावटkरोशनीजोड़ना

D) Reducingmotorpower/मोटरक�शिक्तकमकरना

46. WhilebuildingaBugbot, whatknowledgeiscrucialforcorrectlywiringthesensorsandmotors?/बगबॉटकाfनमार्णकरतेसमय, स्म
औरमोटर◌ोकोसहkढंगसेवाय◌ंरंगकरनेकेfलएकौनसा◌ंानमहत्वपूणर्है?

a) Circuitryandelectronics/क्षेरkऔरइलेक्ट्रॉfनक्स

b) Optics/प्रकाfशक◌

c) Fluidmechanics/तरलयांfत्रक◌

d) NuclearPhysics/परमाणुभौfतक◌

47. Inadisaster–hitarea, aBugbotisdeployedforsearch–and–rescue. Howcouldits sensorsbeenhancedtodetectlivingbeingsunderrubble? /आपदाग्रभाfवत ◌ंेत्रम◌ंखोजऔरबचावकेfलएएकबगबॉटकोतैनातfकयाजाताहै।मलबेकेनीचेजीfवतप्राfणय◌ं कप्रतालगानेकेfलएइसकेस◌ंसरकोकैसेबढ़ायाजासकताहै?

a) Usingthermalsensors/थमर्लस◌ंसरकाउपयोगकरना

b) Addingmorewheels/अfधकपfहएजोड़ना

c) Reducingbatterypower/बैटरkक◌ंशिक्तकमकरना

d) Increasingthesizeoftheframe/फ्रेमकाआकारबढ़ाना

48. WhatistheprimaryfunctionofsensorsinIoTdevices?/IoTउपकरण◌ंम◌ं◌ंसरकामुख्यकाय्रक्या◌ंहै?

a) Processingdata/डेटाक◌ंप्रोसेfसंग

b) Collectingdata/डेटाकासंग्रहण

c) Storingdata/डेटाकासंग्रह

d) Sendingnotifications/सूचनाएंभेजना

49. HowdoesIoTimprovedailylifeinsmartcities?/स्मर्शहर◌ंम◌ंIoTदैfनकजीवनकोकैसेसुधारताहै?

a) Byincreasingenergyusage/ऊर्उपयोगबढ़ाकर

b) Byprovidingreal–timetrafficupdates/वास्तfवकसमयय◌ंफfकअपडेटदेकर

c) Bydisconnectingdevices/उपकरण◌ंकोfडसकनेक्टकरके

d) Byreducinginternetspeed/इंटरनेटस्पीडकोकमकरके

50. AstudentiscreatinganIoTprojecttowaterplantsautomaticallywhenthesoilisdry. Whatcomponentsshouldtheyusetodetectsoilmoistureandcontrolthewaterpump?

/एकछात्रएकIoTप्रयोजनाबनारहाहैताfकfमट्टkकेसूखजानेपरपौध◌ोस्वचाfलतक

सेपानीfदयाजासके।इस्क्रि मट्टkक�नमीकापतालगानेऔरपानीकेपंपकोfनयंfत्रतकरनेकेfलएfकनघटक�काउपयोगकरनाचाfहए?

a) Soilmoisturesensorandmicrocontroller/fमट्टkक�नमीस�सरऔरमाइक्रोकंट्रोलर

b) TemperaturesensorandLEDlight/तापमानस�सरऔरएलईडीलाइट

c) Wi-Fimoduleandspeaker/वाई-फाईमॉड्यूलऔरस्पीकर

d) Cameraandmotiondetector/कैमराऔरमोशनfडटेक्टर

51. **Assertion(A):**Aschoolshouldimplementsmartlightswithmotionsensorstoreduce energyconsumptionbyautomaticallyturningofflightswhennooneispresent.

कथन(A):एकस्कूलकोऊर्जाक्षय[k]खपतकोकमकरनेकेfलएमोशनस�सरकेसाथस्मार्टलाइट्सलागूकरनाचाfहएताfकजबकोईउपिस्थतनहो, तोलाइटअपनेआपबंदहोजाए।

Reason(R): Smartthermostatscontrolroomtemperatureandcontributetoenergysavingsbyadjusting heatingorcoolingbasedonoccupancy.

कारण(R):स्मार्थम�स्टेटकमरेकेतापमानकोfनयंfत्रतकरतेहैऔरउपिस्थfतकेआधारपर हkfटंगयाकूfलंगकोसमायोिजतकरकेऊर्जाक्षयबचत[k]गदानदेतेह[k]।

a) BothAssertion(A) andReason(R) aretruebutReason(R) isnotthecorrectexplanationforAssertion(A)/दोन[k]कथन(A)औरकारण(R)सहkह[k], लेfकनकारण(R)कथनक[k]सहkव्याख्यानहkंहै।

b) BothAssertion(A)andReason(R)aretrueandReason(R)isthecorrectexplanationforAssertion(A)/ दोन[k]कथन (A) औरकारण (R) सहk[k]औरकारण(R)कथनक[k]सहkव्याख्याहै।

c) Assertion(A)istruebutReason(R)isfalse/कथन(A)सहkहै, लेfकनकारण (R)गलतहै।

d) Assertion(A)isfalsebutReason(R)istrue/कथन(A)गलतहै, लेfकनकारण(R)सहkहै।

52. **Assertion(A):**Amotionsensoristhemostimportant IoTcomponenttoincludeina smarthomemodelforsensingmotion.

कथन(A):गfतकाअनुभवकरनेकेfलएस्मार्टहोममॉडल[k]मोशनस[k]सरसबसेमहत्वपूर्ण IoT घटकहै।

Reason(R): Anactuatorisusedtosensemotioninasmarthomemodel.

कारण(R):एकएक्ट्युएटरस्मार्टहोममॉडल[k]गfतकाअनुभवकरनेकेfलएउपयोगfकयाजाताहै।

a) BothAssertion (A) andReason (R) aretruebutReason (R) isnotthecorrectexplanationforAssertion (A) / दोन�कथन (A) औरकारण (R) सहkह�, लेfकनकारण (R) कथनक�सहkव्याख्यानहk◌ंहै।

b) BothAssertion (A) andReason (R) aretrueandReason (R) isthecorrectexplanation forAssertion (A) / दोन�कथन (A) औरकारण (R) सहk�औरकारण (R) कथनक�सहkव्याख्याहै।

c) Assertion (A) istruebutReason (R) isfalse/कथन (A) सहkहै, लेfकनकारण (R) गलतहै।

d) Assertion (A) isfalsebutReason (R) istrue/कथन (A) गलतहै, लेfकनकारण (R) सहkहै।

***

ANNEXURE - C

TOOL NO. 03 / टूल संख्या 03

BASIC INFORMATION/ बुनियादी जानकारी

Student Name/छात्र का नाम:_____

School Name/स्कूल का नाम:_____

Class/कक्षा:_____

Name of Your ATL In-Charge/आपके ATLइंचार्ज का नाम:_____

Name of Your AIM Mentor of Change/आपके AIM मेंटर ऑफ चेंज का नाम:_____

Date/दिनांक: _____

Section A / खंड A

1. **Suppose the cap of your bottle is lost then what will you 'prefer NOT TO DO'?**
   मान लीजिए आपकी बोतल का ढक्कन खो गया है, तो आप 'क्या करना पसंद नहीं करेंगे'?

   a) Throw the bottleinto trash/ **बोतलको कूड़ेदान में फेंकना**

   b) Reuse the bottle for plantation/ **बोतलको पौधरोपण के लिए पुनः उपयोग करना**

   c) Using the bottle for decoration purpose/ **बोतलको सजावट के उद्देश्य से उपयोग करना**

   d) Making the bottle a bird feeder/ **बोतलको पक्षी आहार पात्र बनाने के लिए उपयोग करना**

2. **In the picture given below if you get a chance to modify anything what will you prefer the most:/नीचे दी गई तस्वीर में, यदि आपको किसी चीज़ को संशोधित करने (बदलने) का मौका मिले तो आप सबसे अधिक क्या करना पसंद करेंगे:**

a) Changing the colour of traffic lights/ **ट्रैफिक लाइट्स का रंग बदलना**

b) Shifting the positions of traffic lights/ **ट्रैफिक लाइट्स की स्थिति बदलना**

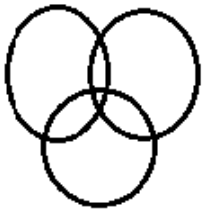
c) Changing the pattern of zebra crossing/ **जेब्रा क्रॉसिंग का पैटर्न बदलना**

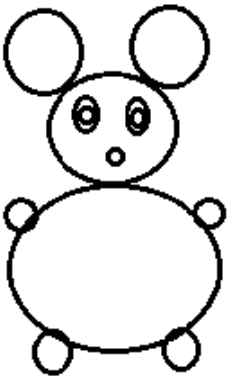
d) Designing the system to power the traffic light using a solar panel/ **सोलर पैनल का उपयोग करके ट्रैफिक लाइट को पावर करने के लिए सिस्टम डिजाइन करना**

3. **If you are given 'n' number of circles then what would you like to make with these circles: यदि आपको 'n' संख्या के वृत्त दिए जाते हैं, तो आप इन वृत्तों से क्या बनाना पसंद करेंगे:**

a. 

b. 

c. 

d. 

4. **How often do you get the opportunity to modify anything in ATL? / आपको ATL में किसी चीज़ को संशोधित करने का अवसर कितनी बार मिलता है?**

a) Very often/ **बहुत बार**

b) Often/ **अक्सर**

c) Rare/ **कभी-कभी**

d) Never/ **कभी नहीं**

5. **Using the following components what will you create? / निम्नलिखित घटकों का उपयोग करके आप क्या बनाएंगे?**

   Technical – LED, resistor, buzzer, servo motor, ultrasonic sensor and Arduino
   तकनीकी –एल.ई.डी., रेसिस्टर, बजर, सर्वो मोटर, अल्ट्रासोनिक सेंसर और Arduino
   Non – technical – used pens, filled notebooks and plastic bottles
   गैर–तकनीकी–उपयोगकिए गए पेन, भरी हुई नोटबुक और प्लास्टिक की बोतलें

_____
_____
_____
_____
_____

The creativity of the answer can be measured from the following parameters:/ उत्तर की रचनात्मकता को निम्नलिखित मापदंडों से मापा जा सकता है:

1. Originality/ **मौलिकता**
2. Logicalness/ **तार्किकता**
3. Usefulness/ **उपयोगिता**
4. Understanding/ **समझ**
5. Well-crafted/ **अच्छी तरह से तैयार किया गया**

***

Section B / खंड B

Instructions/निर्देश-

(collect project reports of innovative projects/ **नवोन्मेषी परियोजनाओं की परियोजना रिपोर्ट एकत्र करें)**

(innovation rubric to be made/ **नवाचार रूब्रिक बनाई जाए)**

(to be checked on ATL and Non-ATL groups/ **ATL और गैर-ATL समूहों में जांचा जाए)**

(Self-developed / Guided by mentor/ **स्व-विकसित/मार्गदर्शक द्वारा मार्गदर्शित)**

(Team answer required/ **टीम का उत्तर आवश्यक है)**

(component identification/ **(घटक की पहचान)**

1. **Have you ever got the opportunity to innovate or modify anything? / क्या आपको कभी कुछ नया करने या किसी चीज़ को संशोधित करने का मौका मिला है?**
   (Yes / No)**(हाँ / नहीं)**

2. **Have you ever made some modifications in anything like a device, material, toys, etc. for its better use/purpose? / क्या आपने कभी किसी उपकरण, सामग्री, खिलौने आदि में उसके बेहतर उपयोग/उद्देश्य के लिए कोई संशोधन किया है?**

_____
_____
_____
_____
_____
_____

***

Section C / खंड C

1. **In which case in a real-world situation the design thinking could not be solved? / वास्तविक दुनिया की स्थिति में कौन से मामले में डिजाइन थिंकिंग का उपयोग नहीं किया जा सकता है?**

   _____
   _____
   —

2. **Which stage of design thinking involves understanding the need and experience of others? डिज़ाइन थिंकिंग का कौन– साचरण दूसरों की आवश्यकता और अनुभव को समझने में शामिल है?**

   a) Ideation/**विचारमंथन**
   b) Prototype/**प्रोटोटाइप**
   c) Empathize/**समानुभूति**
   d) Define/**परिभाषित करना**

3. **Which of the real-world problem could not be solved using design thinking? / निम्नलिखित में से कौन–सीवास्तविक दुनिया की समस्या को डिजाइन थिंकिंग का उपयोग करके हल नहीं किया जा सकता है?**

   a) Mitigating climate change/**जलवायु परिवर्तन को कम करना**
   b) Solving algebra problems/**बीजगणित की समस्याओं को हल करना**
   c) Developing new eco-friendly products/**नए पर्यावरण-अनुकूल उत्पादों का विकास करना**
   d) Designing a user-friendly App for the blind/**दृष्टिबधित उपयोगकर्ता के अनुकूल ऐप डिज़ाइन करना**

4. **When you think of a fun idea for a new science project, what part of design thinking are you exactly doing? / जब आप एक नए विज्ञान परियोजना के लिए एक मजेदार विचार सोचते हैं, तो आप डिजाइन थिंकिंग के किस हिस्से को अंजाम दे रहे हैं?**

   a) Testing the idea/ **विचार का परीक्षण करना**
   b) Empathize idea/ **विचार के साथ समानुभूति करना**
   c) Prototype the idea/ **विचार का प्रोटोटाइप बनाना**
   d) Ideate the idea/ **विचार का मंथन करना**

5. **If you invent a new playground slide and want to make sure it's safe for your friends, what should you do? / यदि आप एक खेल के मैदान में नयी स्लाइड का आविष्कार करते हैं और यह सुनिश्चित करना चाहते हैं कि यह आपके दोस्तों के लिए सुरक्षित है, तो आपको क्या करना चाहिए?**

   a) Test the new slide/ **नई स्लाइड का परीक्षण करें**
   b) Define the new slide/ **नई स्लाइड को परिभाषित करें**
   c) Ideate the new slide/ **नई स्लाइड का विचार करें**
   d) Prototype/ **प्रोटोटाइप**

***

Section D / खंड D

Note: All the items are directly concerned with ATAL Tinkering Labs and their entrepreneurial environment.
नोट: सभी आइटम सीधे ATAL टिंकरिंग लैब्स और उनके उद्यमशील वातावरण से संबंधित हैं।

S. No / क्रमांक	Items / आइटम	Strongly Agree / बिल्कुल सहमत	Agree / सहमत	Neither Agree nor Disagree / न तो सहमत न असहमत	Disagree / असहमत	Strongly Disagree / बिल्कुल असहमत
1	The training programmes of my ATL are effective and relevant to modern needs. / मेरे ATL के प्रशिक्षण कार्यक्रम प्रभावी हैं और आधुनिक ज़रूरतों के अनुरूप हैं।					
2	Sessions to understand the concept of entrepreneurship development have been effectively conducted in my ATL. / मेरे ATL में उद्यमिता विकास की अवधारणा को समझने के लिए सत्र प्रभावी ढंग से आयोजित किए गए हैं।					
3	Development and processing of Intellectual Property registrations have been explained clearly in my ATL. / मेरे ATL में बौद्धिक संपदा पंजीकरण के विकास और प्रसंस्करण को स्पष्ट रूप से समझाया गया है।					
4	Marketing and sales of developed innovative prototypes and service ideas have been explained clearly in my ATL. / मेरे ATL में विकसित नवाचारी प्रोटोटाइप और सेवा विचारों के विपणन और बिक्री को स्पष्ट रूप से समझाया गया है।					
5	Interpretations of sustainable business policies and regulations in promoting social welfare have been					

	explained clearly in my ATL. / मेरे ATL में सामाजिक कल्याण को बढ़ावा देने के लिए सतत व्यापार नीतियों और विनियमों की व्याख्याएं स्पष्ट रूप से समझाई गई हैं।					
6	**My ATL In-charge is equipped with entrepreneurial knowledge. / मेरे ATL प्रभारी उद्यमिता ज्ञान से सुसज्जित हैं।**					
7	**My assigned AIM Mentors-of-Change (MOCs) are equipped with entrepreneurial knowledge. / मेरे नियत AIM मेंटर– ऑफ - चेंज (MOCs) उद्यमिता ज्ञान से सुसज्जित हैं।**					
8	**Institutional Leadership of my ATL is effective and efficient. / मेरे ATL का संस्थागत नेतृत्व प्रभावी और कुशल है।**					
9	**My ATL environment is pro-entrepreneurship development. / मेरा ATL वातावरण उद्यमिता विकास समर्थक है।**					

***

ANNEXURE - D

TOOL no. 1

To study the status of the use of Atal Tinkering Labs (ATLs) in Secondary Schools of the Western Region in India

Questionnaire for Data Collection

Section A: Demographic Information

- **Name of the School:**_____
- **Location (City, District, State):** _____
- **Areas (Metropolitan/ Urban /Semi-Urban/Rural):** _____
- **Respondent's Role in ATL Administration(Principal/ATL In-charge /Mentor of Change) :** _____
- **Nature of the management (Public School/Private School/ Minority Institution):**_____

Section B: Awareness and Usage of ATL

1. **Are following infrastructure components available and currently operational in your ATL?**
   - Electronics Development, Robotics, Internet of Things, and Sensors**(Yes/No)**
   - Rapid Prototyping Tools**(Yes/No)**
   - Mechanical, Electrical, and Measurement tools**(Yes/No)**
   - Power Supply, Accessories, and Safety equipment**(Yes/No)**

2. Level of Grant from NITI Aayog:
   - Tranche 01**(Yes/No)**
   - Tranche 02**(Yes/No)**
   - Tranche 03**(Yes/No)**

3. How far has the ATL of your institution beenable to thematically integrate the concepts of science and technology from the curriculum?
   - Very Effective
   - ModeratelyEffective
   - Average Effective
   - Not Effective at All

4. How effectively childrenareinvolved with ATL offered opportunities to work with relevant tools and equipmentto understand the concepts of – **robotics,IoT,3-D Printing, basic electronics,product prototyping, and arts and crafts**?
   - Very Effective
   - Moderately Effective
   - Average Effective
   - Not Effective at All

5. **Identify the statistics associated with the different levels of student engagement in your ATL as mentioned in the table below:**

Sl. No.	Form Of Student Participation	Average Yearly Value For The Last Five Years

1	PRE-TINKERS	
2	TINKERS	
3	POST TINKERS	
4	COMMUNITY STUDENTS	

6. Total current strength of students enrolled at the secondary level (9^{th} + 10^{th}) in your school _____.

7. Mentor and Teacher Involvement in your ATL
   I. Number of Mentor Of Change (MOCs) associated with your ATL_____.
   II. Number of Mentor Of Change (MOCs) actively engaged with your ATL_____.
   III. Designation of ATL In-Charge _____.
   IV. Qualification of ATL In-Charge_____.
   V. Length of serviceof ATL In-Charge in teaching
      1. 0 to 5 years
      2. More than 5 and up to 10 years
      3. More than 10 and up to 15 years
      4. More than 15 years
   VI. Is there any Exemplary Teacher OfChange (ETOC) in your school.

8. Student engagement programmes and activitiesthroughyour ATL for the last five years.

Sl. No.	**Activity/Programme**	**Number**
1	Participation in the AIM Hackathon	
2	Participation in the ATL Tinkerpreneur	
3	Total Innovations registered with AIM	
4	Total Innovations registered in the Top List of Marathon with AIM	
4	Number of Intellectual Property Rights (IPR) Granted	
5	Number of Intellectual Property Rights (IPR) under Process	
6	Number of Workshops and Seminars conducted	
7	Number of Expert Talks conducted on a particular theme	
8	Number of Online Interaction sessions	
9	Number of Offline Interaction sessions	
10	Exhibition participations	
11	Number of achievement days celebrated (for eg. National Science Day, National Space Day etc.)	
12	Number of visits of your ATL team for industry institute interaction programme.	

9. Partnerships of your ATL with others.

- MoUs with Private Partners (if any)

  _____

  _____

  _____

- Is your ATL In–charge associated with any other ATL outside your own ATL as MOC? (Yes/No)

10. How do you rate the influence of ATL on your school in helping the students to shape better prospects in terms of – attaining highereducation, vocational skill development, job, and entrepreneurship (start-ups, influencers, etc.)?

- Very Effective
- Moderately Effective
- Average Effective
- Not Effective at All

11. How do you rate your academic leadership in implementing the ATL Project effectively?'
    - Excellent
    - Very Good
    - Good
    - Average

12. Have you faced any challenges while implementing the ATL Project in your school? **(Yes/No)**

If Yes, mention some specific challenges.

_____
_____
_____
_____

ANNEXURE - E

INTERVIEW SCHEDULE

Must needed Information Full/Partial Operational Status of ATL: Try to get maximum output

1. Local Mentor has been empanelled or not? (S)
2. MoU with a Company has been done or not? (Essential) (S)
3. Advisory Committee exists or not?[Structure: 16 members, viz, 1 Chairman – Local Company Head; 1-member Local Government Panchayati Raj; 2 members school: Principal-Lab Chairman, ATL in – Charge – Lab Secretary; 2 members Academicians; 2 student members; 4 parents; 2 school teachers; 1 respected community representative] (S)
4. Minutes of Advisory Committee can be sought (1 minutes per quarter for post Covid sessions, viz, 2021 – 2022, 2022 – 2023, 2023 – 2024) (S)
5. Lab inspection report can be sought (Annual Local CA Reports, Fund audit, E&T (Expenses and Transaction Report), QCI (Quality Control of India) Report). (S)
6. Savings Bank Account of ATL whose interest generated is transferred to RBI.(S)
7. How many Community schools have been adopted by the ATL? (Certificates from the Principal can be sought). (S)
8. Number of International Accolades won (S)
9. Number of National Accolades won (S)
10. Number of State Accolades won (S)
11. Number of Local Accolades won (S)
12. How many State level competitions have been organized by the ATL lab with a condition that the host ATL is not a participant? (S)
13. How many SIP (Student Innovator Programme) and SEP (Student Entrepreneurship Programme) have been attended by the ATL which are organized by 72 listed companies? [This is amongst the main purpose of Niti Aayog in establishing the ATLs.] (S)
14. How may SEPs (Student Entrepreneurship Programmes) have been won by the ATL? [For last four years this is being organized in Pune]. (S)
15. How many products have received confirmed patent status from your ATL? (S)
16. Social media account of the ATL which empanels each and every function of the lab and tags Niti Aayog. (OPERATIONAL STATUS EVIDENCE) (S)
17. According to you what is the STRENGTH of ATL?

    Are the tools and equipment in the ATL of high quality and effective for student use? What problems have you observed with the current resources, and what improvements are needed?

    4. How well does the ATL curriculum align with the needs and interests of the students? What aspects of the curriculum do you find particularly effective in developing students' skills? Are there any gaps in the curriculum that hinder the development of students' skills?

    5. Do you notice high levels of student engagement and motivation in ATL activities? What factors contribute to this positive engagement?

6. Which specific skills or competencies do students effectively develop through ATL activities?Can you provide examples of student projects that demonstrate these skills?Are there any specific skills or competencies that students struggle to develop in the ATL?
7. Do students receive adequate guidance and support from mentors in the ATL? What aspects of the mentorship contribute to student success?
8. Do you feel sufficiently trained and supported to effectively facilitate ATL activities? What professional development opportunities have been most beneficial for you?What additional training or professional development would be beneficial for you?
9. How effective is the ATL environment in fostering teamwork and collaboration among students? Can you provide examples of successful team projects and collaborations?Are there any challenges with teamwork and collaboration among students in the ATL?
How effective are the partnerships with local businesses and the community in supporting ATL activities?What additional support or involvement from external partners would be beneficial?
Do students have sufficient opportunities to apply what they learn in the ATL to real-world problems? Can you provide examples of projects that have real-world applications?
What changes have you observed in students' confidence and abilities since participating in ATL activities? Can you share specific stories of student growth and success?
How has participation in the ATL enhanced students' innovation and creativity?What projects or activities have particularly stimulated innovative thinking? What additional opportunities or projects could enhance the real-world applicability of ATL activities?
What opportunities are there to introduce more innovative and effective methods of assessing student projects and learning outcomes? How could these new assessment methods provide better insights into student progress?"
What new topics or areas of study could be added to enhance the curriculum?

18. Have you developed any innovative project using resources available in ATL?

    (Yes / No)

19. If yes what were the salient features of the project which can be considered as innovation?

ANNEXURE - F

TEACHING LEARNING IN ATL

Q. What method of teaching does the teacher follow in the ATL Lab?

1. Lecture , Presentation and Demonstration based learning
2. Facilitation and Moderated Discussion
3. Interactive Direction

Q. In ATL, students learn with the help of-

1. Simulations
2. Hands-on training
3. Drill and practices

Q. **While engaged in ATL -**

1. Individually
2. In pair
3. In small group (4 to 6)
4. In large group (more than 6)

Q. How is the thematic area topic finalized?

1. Authoritatively by the teacher
2. Through negotiation with students

Q. How are students engaged in ATL?

1. Each and every student is engaged
2. Some are engaged

Q. How far technology integrated learning is being implemented

1. High
2. Moderate
3. Low

Q. Teachers come to the ATL with previously prepared learning design.

(Evidence to be collected)

1. Yes
2. No

Q. How vigilant is the teacher in the ATL in individual / group learning?

1. Teacher remain passive
2. Involved in discussion with some of the student
3. Giving attention to each and every student

Q. While assessing the student in ATL, the teacher-

1. Has prepared a rubric and is assessing the students accordingly
2. With the help of the written test.
3. Any other assessment method

ANNEXURE - G

Lab Observation Schedule

- Location of ATL within the school campus (ease of reach)

_____

_____

- Design and arrangement of ATL
  - Seating arrangement

    _____
  - Arrangement of equipments and tools

    _____
  - Display boards for important information

    _____
  - Physical facilities

    _____

- Equipments present in the ATL
- Availability of proper Wi-Fi in the lab.
- Safety precautions
  - First aid kit
  - Fire extinguisher
  - Switch boards condition
  - Do's and Don'ts for students

- Additional facilities provide related to
  - Resources
  - Methodology

- Computers /Tablet
  - Number of system () available and functional
  - Internet connectivity

- Some project by the students (Display of the projects)

- Execution of ATL curriculum
  - Following the curriculum as it is given by AIM
  - Designing their own course by considering ATL objectives
  - Lesson planning or split-up syllabus designing

- Methods adopted by the ATL in-charge for teaching learning process in ATL
  (Demonstration method/team work/hands on activities etc)

- Number of students taking part in ATL per grade

- Alignment of ATL's with school schedule

- ATL dashboard

- Does the ATL possess required carpet area 1500 square feet or more for non – hilly area/1200 square feet for hilly area? (C)

ANNEXURE - H

ILLUSTRATIVE LIST OF EQUIPMENT AND KITS IN ATAL TINKERING LABORATORIES (ATL)

(*Suggested Quantity is for a class of 20-30 students, could be scaled up as needed)

Package 1: Electronics Development, Robotics, Internet of Things and Sensors

Category	Name	Description	Suggested Quantity*	Type
Electronics Development	Arduino UNO or compatible Microprocessor and microcontroller	• Hardware development board with Memory and IO ports •	20	Consumable
Electronics Development	Breadboards & Mini Breadboard	• Solderless 400 points and 800 points • Self-adhesive proto shield	20	Consumable
Electronics Development	General Purpose solderable Board	• Boards of each size of A1, A2 and A3	10	Consumable
Electronics Development	16x2LDC display	• Dot matrix LDC display with 16 characters x 2 lines	10	
Electronics Development	USB Cables	• USB Cable Set (A to B)	20	Consumable
Electronics Development	9 Volt battery, multiple resistors and capacitors for electronic projects (various sizes)	• Amperage • Range of resistance • Capacity of capacitor	20 kits	Consumable

Internet of Things & Sensors	IR Sensors Obstacle sensor	• Detection range • Detection angle	10	Consumable
Internet of Things & Sensors	Triple Axis Magnetometer	• 3-Axis Magnetoresistive • Sensors • I2C Digital Interface • Integrated 12-bit ADC • Range of -8 to +8 Gauss • 160 Hz Maximum Output Rate	5	Consumable
Internet of Things & Sensors	Humidity Sensor	• Operating range: 20-95 %RH • Temperature: 0-60 Celsius • Power supply:1.5V AC(Max sine) • Operating frequency: 500Hz-2kHz	5	Consumable
Internet of Things & Sensors	MQ-4 Natural Gas sensor	• High sensitivity to Methane, Natural gas • Small sensitivity to alcohol, smoke • Fast response • Stable and long life • Simple drive circuit	3	Consumable
Internet of Things & Sensors	IR (transmitter) receiver -TSOP 1738	• Switching rate– 38 KHz	10	Consumable

Internet of Things & Sensors	Ultrasonic Sensor Module HC-SR-04 or compatible	• Power supply • Quiescent current • Working current • Effectual angle • Ranging distance • Resolution • Working angle & dimension	20	Consumable
Internet of Things & Sensors	Triple Axis accelerometer	• 3-axis sensing • Small, low profile package • 4 mm × 4 mm ×1.45 mm LFCSP • Low Power : 350 μA (typical)	5	Consumable

		• Single-supply operation:1.8V to3.6 V • Temperature stability		
Internet of Things & Sensors	PIR Motion Detector Module	• High digital pulse when motion detected • Low digital pulse when idle /no motion detected • Sensitivity range (upto 6 m) • Power supply: 5V– 12V	5	
Internet of Things & Sensors	CMOSIR Camera Module-728x488	• 728 x 488 Resolution • 6V to 20V input • 50mA (at 12V)	2	Consumable
Internet of Things & Sensors	RFID Reader– Tags	• Current :13-26mA / DC 3.3V • Idle Current :10-13mA / DC3.3V • Sleep Current<80uA • Peak Current<30mA • Operating Frequency: 13.56MHz<30mA • Read range between 20 cm tolm	3	Consumable
Internet of Things & Sensors	RF Modules Tx & Rx 315 MHz ASK	• Frequency Range: 433.92/315 MHz • Supply Voltage: 3–6 V • Output Power : 4–16 Dbm • Low power consumption • Easy application	5	Consumable

Internet of Things & Sensors	Voice Recognition	• Works on 4.5 to 5.5VDC • Digital Interface: 5V TTL level UART interface • Working Current < 40mA • Small size	1	Consumable
		• Can recognize 5 commands at one time • Can record up to 15 commands		
Robotics	Stepper motor with Driver board	28BYJ-48 ULN2003 5V Stepper Motor + ULN2003 Driver Board	5	Consumable
Robotics	DC motor	3-6 V, 2000 RPM for electric toy car, EK2153 or equivalent	5	Consumable
Robotics	4 Wheel robot car chassis kit	Car kit with DC motors, encoder, battery case LINK	3	Consumable
Robotics	Servo motors	3types • Positional rotation servo • Continuous rotation servo • Linear servo	20	Consumable
Robotics	DIY Robotic kits		3-5	Consumable

Package 2: Rapid Prototyping Tools

Category	Name	Description	Suggested Quantity	Type
Rapid Prototyping Tools	3D Printer Kit and tools	1.75 mm PLA Printer, With 180mm ×200mm ×160mm Build Volume, Spatula, Tweezers, Cutter, Screwdriver, Wrench etc.	1	Equipment
Rapid Prototyping Tools	Filament for 3D printer	1.75mm PLA filament 750-1000 g spools	5	Consumable
Rapid Prototyping Tools	Set of Arts & Crafts Accessories– eg-stationary items and basic prototyping material	Cardboard, foam core boards, string, rubberband, popscicle sticks, wood glue, balsawood sheets &rods	5 5 50m 100 100 1btl assort	Consumable

Package 3: Mechanical, Electrical and Measurement tools

Category	Name	Description	Suggested Quantity	Type
Mechanical Tools	Hacksaw	Junior	1	Equipment
Mechanical Tools	Micro Chisel Set		1	Equipment

Mechanical Tools	Pliers	• External Straight • Nose Circlip Plier • Long Nose Plier • Combination Mini Plier • Wire stripping pliers • Bent nose plier Needle nose pliers	1set	Equipment
Mechanical Tools	Mini Hack Saw		1	Equipment
Mechanical Tools	Ball Pen Hammer		1	Equipment
Mechanical Tools	Steel Shaft Claw Hammer		1	Equipment
Mechanical Tools	Fiber Glass Nail Hammer		1	Equipment
Mechanical Tools	Rubber Mallet		1	Equipment
Mechanical Tools	C-Clamp		5	Equipment
Mechanical Tools	Allen Key Set		1	Equipment
Mechanical Tools	Workstation for drilling		1	Equipment
Mechanical Tools	12 piece combination Spanner Set		1	Equipment
Mechanical Tools	12 Piece Open ended Spanner Set		1	Equipment
Mechanical Tools	30Piece Ratcheting Screwdriver Set		1	Equipment

Mechanical Tools	Baby Vice 60 mm		1	Equipment
Mechanical Tools	6 Piece Precision Screw Driver Set		3	Equipment
Mechanical Tools	Adjustable Spanner		2	Equipment
Mechanical Tools	Wire Strippers	Wire Stripper Cutter Plier With Spring -26x6x20 Cms (LxWxH)	5	Equipment
Mechanical Tools	Screwdriver	Multi-purpose	5	Equipment
Mechanical Tools	ToolSet	Multi-purpose	3	Equipment
Electric Tools	Hot glue gun + Glue Sticks	Range in open space (Standard Conditions) : 100 Meters	2	Equipment

Electric Tools	Soldering Iron Kit Temperature Controlled Soldering Station	Variable Wattage of Soldering Iron: 15-30 watts/230 volts Soldering Iron Temperature Range: 280°C to 450°C	2	Equipment
Electric Tools	DC Power Supply	0-30V,1 A digital DC power supply with variable adjustment	3	Equipment
Electric Tools	Cables	Micro USB, Mini USB, USB A-USB B, USB-USB. Each 10 pieces	10	Consumable
Electric Tools	Adapters	DC power Adapter with 5V, 12V. Each 10	10	Consumable
Electric Tools	Electric Screw Driver Set		1	Equipment
Electric Tools	1800 W Dual Temperature Heat Gun		1	Equipment
Measurement Tools	Return measuring tape 5Mx19mm		2	Equipment
Measurement Tools	Stainless Steel 12” / 150 mm Rule		5	Equipment
Measurement Tools	150 mm / 6” Digital Vernier Caliper		2	Equipment
Measurement Tools	12” Spirit Leve		1	Equipment
Measurement Tools	Digital Pen electric Tester	Voltage		Equipment
Measurement Tools	Digital Multi Meter	• Digital Multi Meter Voltage Current Resistance-7 functions + 19 ranges to cover	5	Equipment

		DC voltage 200mV to 1kV, • AC voltage 200 V-750V, • DC current 200 µA-10 A • Resistance 200-2M Ohm and Transistor & diode test.		

Package 4: Construction kit, Power Supply, Consumables, Accessories and Safety Equipment

Category	Name	Description	Suggested Quantity	Type
Construction kit	STEM Modular Construction kits		2	Equipment
Power Supply & accessories	9 volt battery clips		20	Consumable
Power Supply & accessories	Hookup Wires	Red & Black set 100 Meters each	2	Consumable
Power Supply & accessories		Jumper Cable: Male-Male Male-Female Female-Female	 400 80 50	Consumable
Power Supply & accessories	Power Strip for power adaptors		10	Consumable

Safety equipment	Standard first aid kit		1	Consumable
Safety equipment	Fire extinguisher (handy units)		1	Consumable
Safety equipment	Safety goggles (with/ without LED torch)		10	Consumable

ANNEXURE – I

WORKSHOPS CONDUCTED FOR RESEARCH PROJECT

The Institute organized a five-day workshop for the research project titled "**Effectiveness of Atal Tinkering Lab on Learning Outcomes and in promoting 21st century skills for secondary school students of Western Region".** The Resource Persons contributed in this workshop by sharing their experiences and expertise.

1st Workshop-

From August 20-24, 2024: For Designing of Tools.

Following Resourse Persons attended the 1st workshop-

Prof. Ramakar Raizada,

Ex Faculty NCERT

Dr. Mrinal Mukherjee

Assistant Professor, Department of Teacher Education,
Baba Saheb Ambedkar Education University (Erstwhile WBUTTEPA) , 25/2 & 25/3 Ballygunge Circular Road, Kolkata 700019, West Bengal, India

Dr. Laxmiram Gope

Assistant Professor,
Sidho Kanho Birsha University, Purulia

Dr. Kalpana Maski

Assistant Professor,

DESM, RIE Bhopal

Dr. Pradhyuman Singh Lakhawat

Assistant Professor,

DESSH, RIE Bhopal

Mr. Amritanshu Vajpayee

Ms. Divya Maithli

Ex ATL Incharge,

Sagar Public School Bhopal

Outcome of the 1st Workshop-

- **8 TOOLs** (for Students, Teachers and Principals) were designed by the experts after meticulous discussion and brainstorming.
- A pilot study using the tools was done in the ATL of Demonstration Public School, NCERT, Bhopal.

2nd Workshop –

From February 17-21, 2025: For Data Analysis and Report Preparation.

Following Resourse Persons attended the 2nd workshop -

Prof. N. Pradhan

Ex Faculty, NCERT
West Bengal.

Dr. Ashwini Garg

Associate Professor, DESM,
NCERT, Bhopal

Dr. Mrinal Mukherjee

Assistant Professor, Department of Teacher Education,
Baba Saheb Ambedkar Education University (Erstwhile WBUTTEPA) , 25/2 & 25/3 Ballygunge Circular Road, Kolkata 700019, West Bengal, India

Dr. Laxmiram Gope

Assistant Professor,
Sidho Kanho Birsha University, Purulia

Dr. Kalpana Maski

Assistant Professor,

DESM, RIE Bhopal

Dr. Pradhyuman Singh Lakhawat,

Assistant Professor,

DESSH, RIE Bhopal

Mr. Amritanshu Vajpayee

Ms. Divya Maithli

Ex ATL Incharge,

Sagar Public School Bhopal

Outcome of the 2nd Workshop -

- Data analysis of the collected data was done in consultation with the resource persons.
- Chapterization of the report and draft of the report was prepared.


ATAL TINKERING LABS

Tinker Tinker budding Innovation Stars,

AIM your dreams to take you far,

Inspiring your imaginations to soar so high,

Sparkling like diamonds in the Indian Innovation Sky.

Ramanathan Ramanan

Mission Director,

Atal Innovation Mission,

NITI Aayog

Atal Innovation Mission - Leading Innovation in India

"When I see young generation busy in innovation with enthusiasm like this, my resolve for 'New India' gets stronger. In the 21st century we will be able to get India the place in the world it deserves."

Sh. Narendra Modi
Hon'ble Prime Minister of India