CHAPTER – II

Review of the related Literature

2.1 Review of the related Literature:

Escalation of knowledge in modern times is an accepted fact. A review of related literature in the area of investigation is of prominent significance and its importance cannot be denied in any research. The review of related studies is an art of exacting piece of work calling for a deep insight in order to provide clear-cut perspective to the overall field. The term 'Review' means to organize, to envelope an edifice of knowledge and to show that the present study would be an addition to a particular field. The term 'Literature' refers to the knowledge of a particular area of any discipline, which includes theoretical, practical and research studies. In tracing roots of problems, preparing outlines of the study, discussion and interpretation of the results and writing the research report, review of literature is of utmost importance. The study of related literature is useful to search the update and latest information already available and to define the limits of the specific problem. Research takes an advantage of the knowledge that has been accumulated in the past as a result of constant human endeavours. Review is not only important from theoretical point of view but it also provides guidelines to decide procedure and tools to be used. The keys to the vast store house of published literature may open new doors to source of significant problems and explanatory hypothesis which ultimately provides helpful orientation towards for the selection of procedure.

In the present chapter, the comprehensive and detailed review of research studies related to concerned field are given. Research studies for the review were from encyclopedia, journals, abstracts and other published materials. Some unpublished dissertations were also reviewed from RIE library and are included in this chapter. An attempt has been made to review the available literature on the area under investigation in an exhaustive manner. In the present study the reviews are related to Awareness on ATLs, Attainment of 21st century skills through ATLs, Increase in academic achievement and personality development through ATLs, Comparison of schools with and without ATLs and Social Emotional Learning through ATLs.

Kavya (2019) conducted a study to assess awareness levels of academicians and impact of ATLs through perspective of educators. This study is done on primary data collected through survey and questionnaire and descriptive statistics and chi-square test is used for analysis. The

result of the study indicates that there exists a positive relationship between ATL and academic achievement. The limitations of this paper are that it is confined to south region and only 100 respondents were taken. It focuses on importance of infrastructure and teacher training for ATLs.

Anvit and Vikas (2022) examined how ATLs promote creativity, innovation and cross-cultural learning by emphasizing experiential learning and sensory engagement. The study uses a descriptive research design and stratified random sampling across public and private schools in Maharashtra. It integrates questionnaires and aptitude tests to evaluate both students' and teachers' engagement with ATL activities. This structured approach enables a comparative analysis between different types of schools (public, private rural, private urban), thereby offering a nuanced view of institutional disparities in ATL usage and resource availability. The data analysis reveals meaningful trends—for instance, private urban schools demonstrate higher engagement in lab-oriented activities and face fewer challenges compared to their rural and public counterparts. The paper makes a valuable attempt to evaluate ATL implementation across Maharashtra, it remains limited by its descriptive scope and lack of theoretical and analytical depth.

Umesh R Pawar in his study compares impact of ATLs and non-ATL schools on students' outcome in Nagpur district. The paper asserts that ATL participants exhibit stronger academic results, critical reasoning, and preparedness for modern work environments corroborating broader claims made in policy documents and ATL handbooks. The research presents ATLs as transformative learning spaces that promote creativity, collaborative problem-solving, and exposure to real-world STEM applications. Several limitations undermine the paper's analytical rigor. Firstly, despite using mixed methods, the paper lacks statistical transparency: no sample size, survey instrument design, or inferential analysis is presented. In conclusion, while the paper effectively advocates for the educational and social value of ATLs, it suffers from methodological opacity and limited critical depth.

Dorothy D'Souza (2024) carried out study on the topic, Attainment of 21st century skills through Tinkering Labs. The main concern of the study is to explore both the qualitative and quantitative impact of ATL initiatives on student competencies such as creativity, problem-solving, leadership, and academic performance. The use of descriptive statistics, skewness, and kurtosis to assess normality of distribution, and the application of Pearson's correlation to analyse the link between ATL participation and academic performance, represent

methodologically sound choices. The results show a high correlation (r = 0.87) between engagement with ATL and improved academic performance, a statistically robust finding that supports the study's central hypothesis. It strongly advocates for ATL's expansion and its role in India's education reform, yet they do not adequately address implementation challenges. Issues like funding inequity, training inadequacies, or long-term sustainability of ATL operations are not explored, missing an opportunity for critical insight into systemic barriers.

Ashutosh Raina (2024) investigated on the integration of artificial intelligence (AI) into K–12 education in India through the Atal Tinkering Labs (ATLs) initiative. The document skilfully bridges educational theory and practical module design, with a strong emphasis on learning through "tinkering." It advocates for a learner-centred model in which concepts are introduced through accessible, engaging activities and gradually built into complex applications. This is evident in the structure of the AI base and step-up modules, which incorporate scenarios, problem-solving tasks, and real-world data applications. The collaborative development of the AI modules—featuring contributions from academia, industry, and educational technologists—is another significant achievement. The involvement of stakeholders like NASSCOM, Microsoft, Adobe, and IIT Bombay ensures relevance to real-world applications and future workforce demands. The content is clearly scaffolded, enabling differentiation through the "low floor, high ceiling, wide walls" approach. The modules offer flexibility in exploration and creativity, allowing learners to tinker with Scratch, Python, Pictoblox, and real-world datasets. The emphasis on open-ended problems—such as COVID-19 response logistics and water conservation—further enhances the experiential and interdisciplinary value of ATL-based learning.

Alden (2016) on tinkering in Design & Technology (D&T) education reveals both clear potential and significant gaps in current understanding. While it notes that the English National Curriculum's emphasis on iterative design and collaboration aligns closely with constructivist and guided-discovery pedagogies, empirical research specifically addressing "tinkering" as a standalone strategy remains scarce. Choulerton (2015) and Ofsted (2011) criticize the predominance of teacher-led, linear tasks in Key Stage 3, arguing that these limit pupils' creative agency and fail to foster deep learning through iteration. In contrast, proponents of direct instruction such as Christodoulou (2014) and Lowe (2013) warn that unguided exploration can leave critical factual knowledge unacquired, suggesting that a pure tinkering approach risks superficial understanding unless carefully scaffolded. Cowley (2005) and Muijs and Reynolds (2014) advocate a balanced model, where open-ended tasks are supplemented

by targeted information to prevent cognitive overload and ensure progression. Furthermore, theoretical frameworks from Kolb's experiential learning cycle and Vygotsky's Zone of Proximal Development underscore the importance of reflection and appropriate challenge levels, yet few studies have operationalized these constructs within D&T tinkering contexts. Finally, resource constraints and teacher perceptions of risk highlighted by Alden's interviews suggest that institutional and material factors may inhibit wider adoption of tinkering, pointing to a need for research on sustainable implementation models that reconcile curricular demands with creative experimentation.

Atal Tinkering Lab Handbook (2021) provides strategic insights and operational frameworks for establishing and nurturing ATLs across India. The handbook outlines the objectives, methodologies, and resources required to promote experiential learning, critical thinking, and problem-solving skills among school students. It describes ATL as a flagship initiative that aims to cultivate 21st-century skills such as design thinking, digital fabrication, and computational learning through hands-on, student-led innovation. With over 14,000 schools sanctioned and more than 7,000 operational ATLs by the end of 2020, the initiative reflects a national shift toward integrating creativity and technology in school education. The entire lifecycle of ATL implementation is structured into four core phases Select, Establish, Enable, and Celebrate. It is a vision document outlining a transformative educational journey. It combines policy, pedagogy, and practical implementation strategies to ensure that Indian students evolve into creators and problem solvers by promoting inclusive, project-based learning.

ATL Student Innovator Program (SIP) Handbook is a comprehensive guide to the ATL SIP initiative. It aims to empower school students across India with the skills and mentorship necessary to transition from tinkerers to innovators and eventually into young entrepreneurs. The handbook highlights the framework, pedagogy, implementation strategies, and impact of SIP, showcasing how it integrates innovation into education.

The SIP builds upon this foundation by selecting top ATL performers particularly from the ATL Marathon competitions and mentoring them to refine their ideas into market-ready products. Students are paired with industry mentors or incubators to receive guidance in design thinking, prototyping, intellectual property rights, and business modeling. The SIP encourages experiential learning through project-based activities, bootcamps, and internships hosted by corporate partners and Atal Incubation Centres (AICs). These experiences are structured to

enhance students' 21st-century competencies: creativity, critical thinking, collaboration, and communication.

The program emphasizes hands-on innovation, preparing students to develop Minimum Viable Products (MVPs) and pitch decks. It also introduces students to the Technology Readiness Level (TRL) model, guiding them through stages of prototype development toward commercialization. The SIP also promotes awareness of Intellectual Property Rights, ensuring students retain ownership over their innovations. Programs like the Student Entrepreneurship Program (SEP) are presented as follow-ups to SIP, providing additional mentoring and funding support.

The SIP handbook documents a transformative journey that embeds innovation into India's educational fabric. It reflects AIM's broader mission to democratize access to cutting-edge tools and methodologies, fostering a culture of innovation and entrepreneurship that equips students to address real-world challenges and contribute meaningfully to the vision of an "Aatma Nirbhar Bharat."

Atal Tinkering Lab Operation Manual is a comprehensive guide to establishing, operating, and sustaining Atal Tinkering Labs (ATLs) in Indian schools. The manual aims to support the development of innovation ecosystems by nurturing young innovators through hands-on learning, access to modern tools, and problem-solving activities.

The manual is organized into several parts- establishment phase, management phase, information and documentation systems and financial sustainability. The manual showcases case studies of successful ATL setups, such as the lab at Salwan Government Girls' School in Delhi, and offers annexures with job descriptions, equipment lists, safety guidelines, branding templates, and sample project synopses. These additions make the manual a practical tool for ATL implementation. The manual serves as a blueprint for operational excellence in ATL environments. By focusing on hands-on education, innovation, and community collaboration, it aspires to transform Indian school education from rote-based learning to inquiry-driven innovation, building a future-ready generation of thinkers and makers.

Tinker Handbook is a guide for implementation and effective use of Atal Tinkering Labs. Designed for ATL in-charges, school teachers, students, mentors, and parents, the handbook outlines practical strategies and pedagogical frameworks to help create a culture of innovation, creativity, and hands-on learning within Indian school environments. It emphasizes the

philosophy and purpose of ATLs, to serve as 1500 sq. ft. spaces within schools for students to explore, innovate, and solve real-world problems using tools and technologies. It advocates for instilling a maker mindset through Do-It-Yourself (DIY) projects, collaborative thinking, and integration of modern technologies like sensors, microcontrollers, and computational tools.

Learning modules are structured in five steps as Digital Literacy, Ideation, Design Thinking, Computational Thinking and Physical Computing. The handbook also introduces a four-level implementation framework: Pre Tinker level, Tinker Club, Tinker Lab, Post Tinker Lab. Facilitators are given strategic guidance on classroom setup, time management, and instructional approaches, with an emphasis on collaboration, empathy, and curiosity. Numerous resources including PowerPoint presentations, activity cards, and reference videos are provided in soft copy formats to aid teaching and self-learning.

The Tinker Handbook is not just a manual but a vision document that redefines education as student-led, inquiry-driven, and innovation-oriented. It supports the creation of a national ecosystem where young minds are empowered to become creators, problem solvers, and technology leaders of the future.

"Assessment of Atal Tinkering Labs" Report presents comprehensive and detailed evaluation of Atal Tinkering Labs. The study examines 500 ATLs nationwide, with primary data collection through interviews and focus group discussions, supplemented by secondary data from 1000 ATLs. It is extensive geographic and institutional coverage, encompassing diverse categories such as government vs. private, urban vs. rural, and aspirational vs. non-aspirational districts. This breadth provides a holistic understanding of the ATL ecosystem. The report reveals positive outcomes: 90% of schools house their ATL in the main building, most ATLs adhere to infrastructure norms, and over 90% effectively utilized establishment and maintenance grants. Moreover, 75% of schools report increased student interest in STEM, and 69% indicate a higher rate of students opting for science in higher education highlighting ATL's success in influencing academic trajectories.

The report provides practical and thoughtful recommendations—such as integrating ATL activities into school curricula, fostering industry partnerships, and enhancing the ATL Dashboard interface. However, the absence of a cost-benefit analysis or an evaluation of resource constraints, especially in underfunded schools, limits the strategic utility of these suggestions. In conclusion, the report serves as a foundational assessment that validates ATL's contribution to promoting innovation in Indian education.

2.2 Conclusion:

The literature and evaluative reports on Atal Tinkering Labs (ATLs) presents a compelling narrative of their role in redefining school-level education in India. ATLs, as part of the Atal Innovation Mission, have significantly contributed to fostering innovation, creativity, and 21st-century skills among students. Empirical studies, handbooks, and implementation manuals collectively emphasize hands-on learning, design thinking, computational thinking, and physical computing as central pillars of the ATL ecosystem. These interventions are shown to enhance critical thinking, problem-solving, and digital literacy, especially in resource-constrained schools.

While the ATL initiative has demonstrably improved student engagement and STEM orientation, critical reviews highlight systemic challenges. These include uneven implementation across regions, limited teacher preparedness, inadequate monitoring, and sustainability concerns. Most evaluations commend the pedagogical framework but call for more empirical assessments, stronger theoretical underpinnings, and broader scalability mechanisms.

Overall, ATLs represent a transformative policy intervention, aligning well with the National Education Policy's emphasis on experiential learning. To sustain their impact, ongoing investment in infrastructure, teacher training, and community involvement is essential. Strengthening research and impact evaluation will further refine and expand the ATL model, ensuring it becomes a cornerstone of innovation-driven education in India.