Sattva Knowledge Institute SKI perspective

ADVANCING GENDER EQUALITY IN SCIENCE TECHNOLOGY ENGINEERING MATHEMATICS (STEM) EDUCATION IN INDIA

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Sattva Knowledge Institute (SKI), established in 2022, is our official knowledge platform at **Sattva**. The **SKI** platform aims to guide investment decisions for impact, shedding light on urgent problems and high potential solutions, so that stakeholders can build greater awareness and a bias towards concerted action. Our focus is on offering solutions over symptoms, carefully curating strong evidence-based research, and engaging decision-makers actively with our insights. Overall, **SKI** aims to shift intent and action toward greater impact by influencing leaders with knowledge. All of our content proactively leverages the capabilities, experience and proprietary data from across **Sattva**.

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Abbreviations

FLFP	:	Female Labour Force Participation
HBR	:	Harvard Business Review
HSS	:	High Secondary School
ICRW	:	International Center for Research on Women
ICT	:	Information and Communication Technology
NSS	:	National Sample Survey
NITI	:	National Institution for Transforming India
PS	:	Primary School
SS	:	Secondary School
STEAM	:	Science, Technology, Engineering, Arts, and Mathematics
STEM	:	Science, Technology, Engineering, and Mathematics
UDISE	:	Unified District Information System for Education
UNICEF	:	The United Nations Children's Fund

Executive Summary

Female students in India are **20%** less likely to choose science, technology, engineering or mathematics (STEM) or commerce education compared to their male counterparts. With the fourth industrial revolution driving the demand for **STEM skills** and the creation of **60-65 million jobs** in India's digital core sector, addressing this **gender disparity** becomes crucial. Currently, **96% of students** in India are not pursuing technical or professional education, with girls facing additional challenges to pursue STEM education, thereby increasing their risk of exclusion.

To avoid losing out on the benefits of the **demographic dividend** and replicating the current **gender divide** in the labour force, timely intervention is required. Research shows that young girls aged **8-10** are passionate about **science**, but their interest and self-esteem decline during adolescence leading to low uptake of STEM education in India. Prevailing **gender norms**, **intergenerational barriers**, **limited accessibility**, a**nd affordability** issues hinder their progress in STEM education programs. **Safety concerns** and the high **cost of STEM education** further exacerbate the problem. Additionally, the **absence of innovative and gender-sensitive pedagogy, as well as a lack of female teachers**, contribute to disengagement from STEM education.

The transition from graduation to the workforce reveals a troubling trend, with only **29% of women** who graduate in STEM courses joining the STEM workforce. Barriers such as the **'dual role'** syndrome and a **gender-insensitive work environment** need to be addressed to ensure the participation and retention of women in STEM fields.

R**etaining young girls in STEM at the age of 15 is crucial**. Implementing a combination of **targeted initiatives** and **comprehensive solution**s is crucial for enhancing women's participation in STEM education programs. Promising interventions include programs like the **Plan-It** initiative by ICRW and the World Bank's **Tejaswini** project to improve enrollment, retention, and graduation rates in secondary and higher secondary schools. **Ed-tech interventions** such as **BEI** and **Filo** can address infrastructure, teacher availability and access disparities. Government of India's **Atal Tinkering Labs**, Pratham's **Vigyan Mitra** and **CARE India's** interventions foster curiosity in STEM courses, particularly among women. AnitaB.org comprehensively supports women's transition from education to the tech workforce. These interventions, implemented at various life stages, promote women's engagement and involvement in STEM education and careers.

To achieve scalable impact, a combination of **targeted** and **comprehensive** interventions is necessary. A **lifecycle approach**, exemplified by programmes like **Navgurukul's** year-long residential programme for retaining women in STEM education, is recommended. Creating **cross-cutting collaboration** among different stakeholders, including the **government**, **community organisations**, **parents**, **teachers**, and **students** from middle school to vocational-technical education, is crucial. Uniting **funders** and **implementers** towards this common goal will further strengthen the impact of the **collaboration** leading to the uptake of STEM education by women in India.

From Limitations to Opportunities: The Transformative Impact of STEM Education for Girls

The advent of the Fourth Industrial Revolution has brought about substantial changes in the world, highlighting the importance of digital literacy and, consequently, STEM (Science, Technology, Engineering, and Mathematics) skills. India's core digital sectors are projected to generate between 60 to 65 million jobs by 2025,[1] with many requiring STEM proficiencies. What raises more concern is the data regarding women's involvement in STEM education, which underlines that the likelihood of girls pursuing science or commerce (STEM) education at the school level is 20 percentage points lower compared to boys opting for the same.[2]

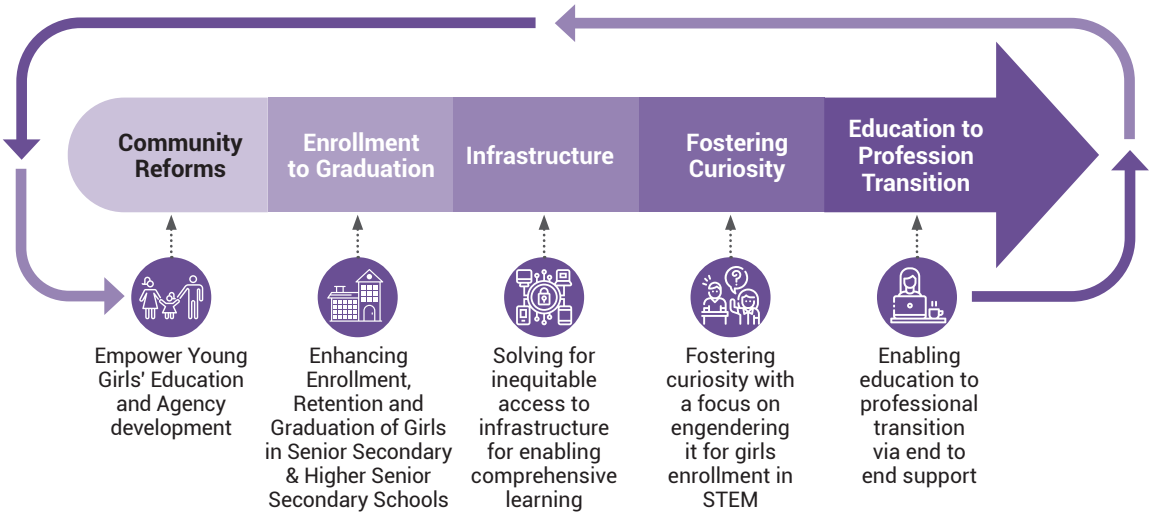
Investing in STEM education for girls has a significant impact on their economic and social empowerment. By equipping girls with STEM skills, they can transition from low-skill jobs to secure and higher-paying positions, addressing the low female labour force participation rate in India.[3] This formalisation of the female workforce has the potential to contribute $700 billion to India's GDP by 2025, thereby boosting economic growth by 1.4%.[4] Furthermore, investing in STEM education for girls not only promotes gender equality but also unlocks their untapped potential. When girls have equal opportunities in STEM, they can challenge gender stereotypes and actively participate in decision-making processes that shape their lives.[5] This dual impact of economic and social empowerment creates a multiplier effect, as women's economic empowerment positively influences societal development.

The engendering of STEM education holds paramount significance in the pursuit of a more equitable and prosperous future as India is poised to emerge as the only country with a talent surplus by 2030.[6] Actively promoting STEM education for girls effectively addresses two crucial challenges. Firstly, it reduces pervasive gender inequality on a global scale by expediting progress towards gender parity. Additionally, it enables the engendered reshaping of the digital ecosystem by incorporating women's perspectives, thereby creating a technological landscape that is for women and by women. Thus, advancing women to meaningfully co-design digital learning strategies and interventions and help evolve gender-responsive education systems. Such an approach allows for course correction in a world that has so far continued to be designed by and for men.[7] Therefore, engendering STEM education is not only a matter of equity but also a strategic imperative.

Acceptability and value of female employment, as well as change in the aspiration of young women are critical determinants in women's workforce participation. With this context, this perspective delves into the barriers that girls continue to face in accessing STEM education and existing interventions to overcome them. The perspective concludes by underlining emphasises on the need for a lifecycle approach, which considers an individual's entire journey, addressing different stages, needs, and challenges, to generate sustainable impact. In the context of women's engagement in STEM fields, adopting a lifecycle

approach recognises the complexity and interconnectedness of their challenges, requiring a multifaceted strategy for effective solutions. By taking into account the entire lifecycle, barriers can be addressed and sustainable outcomes can be achieved.

Figure 1: Lifecycle Approach for Comprehensive Impact



Source: Sattva Analysis 2023

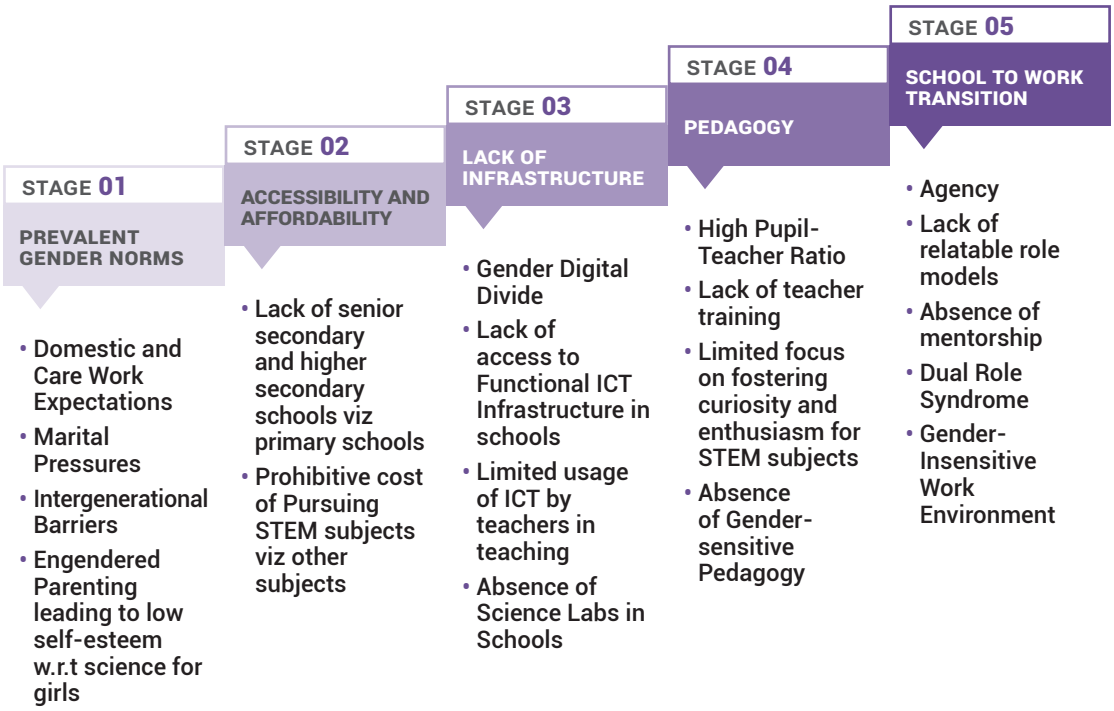
From Education to Profession: Challenges Hindering Girls' Pursuit of STEM

The endeavour to achieve gender equality and inclusivity in STEM education and careers faces many obstacles that impede the active involvement and achievement of women. These challenges encompass diverse areas, including prevailing gender norms and biases, accessibility limitations, infrastructure deficiencies, pedagogical shortcomings, and the barriers around transition from education to the workforce. It is vital to comprehend and confront these challenges in order to establish a fairer and more empowering atmosphere for women in the field of STEM. The framework below (*Figure 2*) highlights the challenges that impede women from taking up STEM education and careers.

Gender Norms and Biases: Hindrances Faced by Women in Choosing Stem

As more and more available and potential jobs are being classified as "STEM" occupations, it is imperative to focus on increasing young girls' participation in, and completion of STEM programmes. Prevalent gender norms lead to care work and domestic work often falling in women's domain of everyday tasks. While care work involves providing physical and emotional support to dependents, domestic work includes tasks related to household functioning. Consequently, these labour-intensive tasks place women in a state of time poverty.[8] These expectations frequently discourage women from pursuing higher education or further studies.

Figure 2: Challenges Faced by Young Girls at Different Stages for Decision Making in STEM



Source: Sattva Analysis 2023

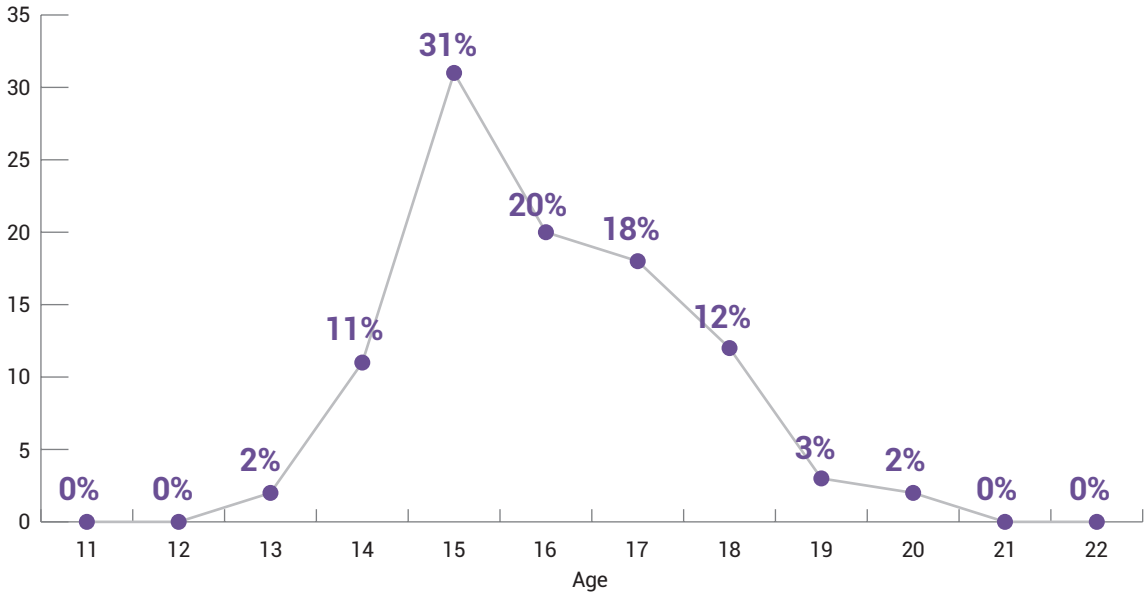
In addition to this, the pressure to marry[9] also becomes a deterrent for higher studies as girls reach adolescence. This is influenced by societal expectations and the specific challenges posed by the perception around marriageability for educated young girls.

Intergenerational barriers, coupled with engendered parenting pose specific hurdles for young girls' access to STEM disciplines. Intergenerational barriers[10] are subconscious barriers that arise from the transmission of personal experiences from parent to child. Parents' perception of STEM and its suitability for their child is influenced by two factors. Parents' own beliefs about their mathematical abilities impact how they encourage or discourage their daughters' involvement in STEM subjects. The perceived limited opportunities in STEM careers also strongly influence their inclination to support or discourage their daughters' engagement with STEM. This tendency may arise from their own childhood experiences, where women's representation in STEM fields was extremely low.

Parents play a significant role in perpetuating gender bias by shaping children's perceptions of gender norms through everyday choices, such as colours and toys[11]. This contributes to the emergence of gender-based differences and varying interests. In STEM, two stereotypes prevail: the belief that boys excel in maths and science, and the perception that STEM fields are predominantly for boys. These gender stereotypes have a detrimental impact on girls' interest, participation, and achievements in STEM, potentially discouraging them from pursuing these careers.

Research shows that girls initially demonstrate interest in STEM during ages 8-10 but experience a decline in self-esteem regarding their competence in these subjects during adolescence.[12] This disparity underscores the influence of gender bias, which hinders girls from pursuing STEM fields. As a result, the interplay between parental influence and gender-based disparities in parenting attitudes moulds the inclinations of young girls, steering them towards subjects and careers that prioritise their domestic and caregiving roles above their professional accomplishments.

Figure 3: Changing Interest in STEM for Young Girls between Age 8 and 15



Source: The STEM Gender Gap, UWS, 2021

The Prohibitive Cost of STEM Impacts Young Girls' Choices

Accessibility and affordability create another set of barriers for young girls in accessing education, alongside the initial challenges posed by gender norms. The accessibility of schools can be influenced by the availability and distribution of primary schools (PS), secondary schools (SS), and higher secondary schools (HSS). Moreover, financial constraints can further hinder girls' access to schools for STEM learning, emphasising the need for consideration of these factors, particularly for girls.

Most schools in India are primary schools (11,96,000), compared to secondary (1,50,000) and higher secondary schools (1,42,000).[13] In rural areas, 92.7% of households have a primary school within 1 km, while in urban areas, it is 87.2%. However, the availability of secondary schools within this distance is lower, with about 38% of rural households and around 70% of urban households reporting their presence. Consequently, as secondary and higher secondary schools tend to lie outside the one-kilometre radius for the majority of students, accessibility becomes a challenge.[14] This emerges as a critical roadblock, hindering students' transition from primary to secondary and further to higher secondary schools. Additionally, factors such as mobility and safety concerns further make access to these schools elusive for the girl child.[15]

STEM education involves a practical aspect to its learning, that necessitates access to specialised equipment, laboratory facilities, and advanced technology. This requirement significantly increases the cost of delivering STEM education compared to other subjects, resulting in higher tuition fees for STEM courses. **The cost of pursuing STEM subjects in urban higher secondary schools is 139% higher than the cost of studying humanities**.[16] Similarly, in rural areas, STEM education is 58.5% more expensive than humanities.[17] In situations where resources are scarce, education is prioritised for male children over female children, due to the perceived notion that investing in the male child's education will yield future returns.

Therefore, a combination of **accessibility and affordability** creates significant barriers for young girls in accessing STEM education. It becomes especially starker for those who face the dual challenges of gender inequality and economic marginalisation.

Unfulfilled Learning Promises: With Only 53.6% of Secondary Schools with Integrated Science Labs, Children are Losing on Learning

In the 21st century's rapidly evolving knowledge economy,[18] digital skills are essential for both organisational competitiveness and individual success, particularly in STEM education and careers. However, access to the digital ecosystem is often influenced by factors like class, caste, and gender, leading to an alarming exclusion of women. Significant disparities are found between adolescent boys and girls worldwide in internet access and digital skills, with South Asia facing the largest gap.[19] For every 100 male youths with digital skills, only 65 female youth possess the same level of proficiency. Ownership of smartphones also presents a challenge, as women have limited access as compared to men.

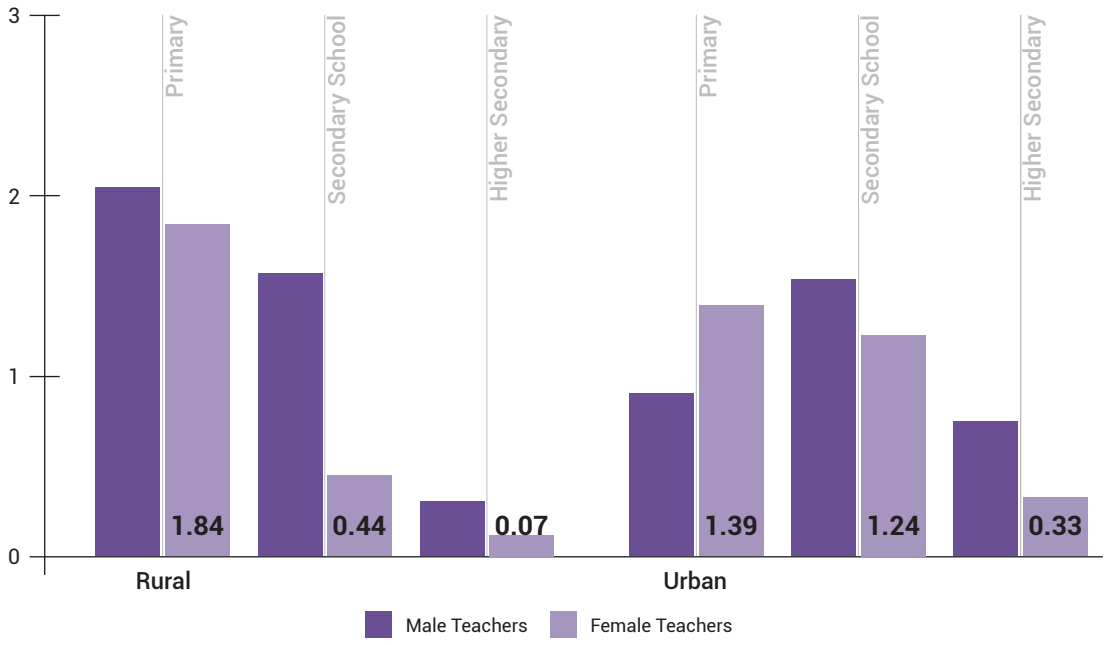
Access to the digital ecosystem is crucial, especially for students interested in STEM subjects. Therefore, schools must be equipped with digital infrastructure to facilitate this engagement. Functional electricity, computers, and internet access are key infrastructural prerequisites for enabling this engagement. While access to electricity is relatively equal among government and government-aided schools, private schools have an advantage. However, the disparity becomes more apparent when considering access to computers and the internet. Government schools lag behind in both areas, with only 32% having access to computers and a concerning 13.6% having internet access. Private schools and government-aided schools fare better, but still exhibit disparities between rural and urban areas.[20]

Mainstreaming ICT in learning is crucial to develop a digitally skilled workforce as India strives to become a trillion-dollar digital economy.[21] However, there are geographic disparities in digital literacy and ICT usage among teachers, with significant variations from state to state. For example, incidence of ICT usage by teachers in schools ranges from 87.67% in Punjab to 4.32% in Mizoram.[22] Lower digital literacy concentration in states with high numbers of aspirational districts raises concerns about inequitable access to digital skills. Addressing these inequities is essential to promote inclusive access to digital skills.

It is equally crucial to ensure access to science labs for comprehensive and holistic learning of students, given the key role that hands-on learning plays in fostering curiosity and interest in science. **Out of the 276,840 secondary schools in India, only 53.6% (148,447 schools) had integrated science lab facilities in 2021-22**.[23] The percentage of schools with science labs varied across different management types: 48.8% for government-managed schools, 59.2% for government-aided schools, and 58.1% for private unaided schools. Additionally, there were noticeable disparities across states — Goa had the highest percentage of secondary schools with integrated science labs (90.9%), while Mizoram had the lowest percentage (26.7%).

The absence of timely interventions to address the disparities in access to digital and STEM infrastructure among schools can have significant repercussions. This is particularly true for students in government schools in general, and female students in particular, who face exclusion both at home and school — potentially exacerbating educational inequalities and hindering their ability to thrive in the digital age.

Figure 4: Gender Distribution of Teaching-Workforce

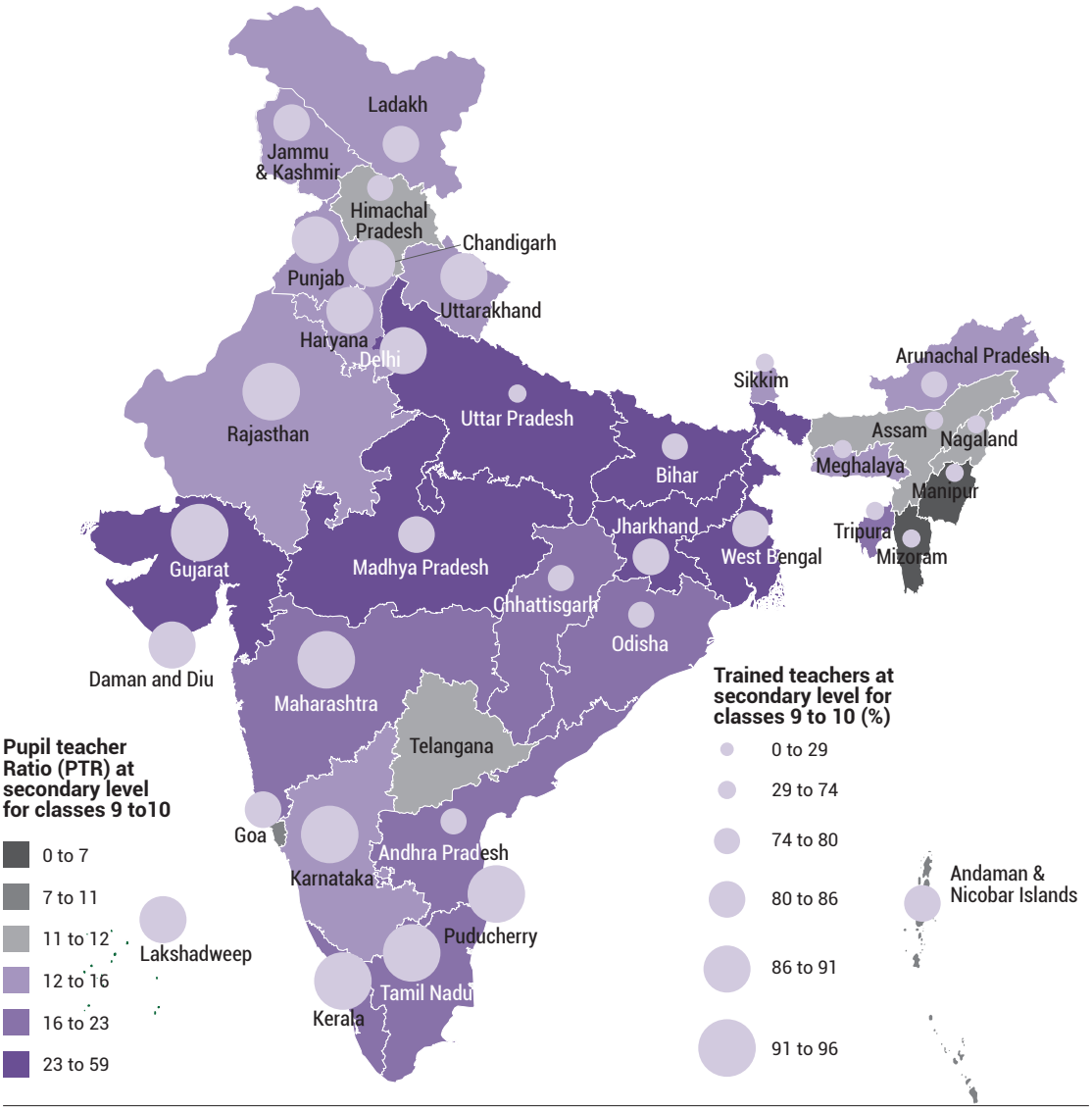


Source: Household Social Consumption on Education in India, NSO, 2018

Pedagogical Barriers: Inhibiting Curiosity and Enthusiasm for Science in Students

The pursuit of holistic and comprehensive learning is the paramount objective in a child's educational journey. However, this aspiration is often hindered by a combination of challenges, including high pupil-teacher ratios, scarcity of trained teachers, and the prevalence of gender-insensitive pedagogy. These obstacles contribute to a lack of enthusiasm and curiosity among students, leading to subpar outcomes, and disinterest particularly in STEM subjects.

Figure 5: Spatial Representation of Pupil Teacher Ratio and Teacher Training



Source: SDG 4, NDAP

The initial challenge arises from the high pupil-teacher ratios,[24] which are particularly pronounced in states with a significant number of aspirational districts. This issue is exacerbated by inadequate teacher training, leaving educators ill-equipped to meet the evolving demands of pedagogy. Only 56.5% of primary school teachers and 65.9% of upper primary school teachers are trained properly.[25] This percentage further diminishes as one progresses to secondary and higher secondary education levels.[26] As a result, the utilisation of effective pedagogical approaches remains limited across states and within schools, constraining the overall learning outcomes for students.

Besides promoting improved learning outcomes for all students, it is equally important to foster an inclusive pedagogy that nurtures curiosity and enthusiasm. Gender-sensitive pedagogy is identified as the key to promoting a gender-responsive and integrative approach

for imparting knowledge that girls need to interact with the world and effectively participate in the workforce of the future.[27] This includes breaking disciplinary boundaries, bringing Arts and STEM together via STEAM[28] modules and enhancing STEM learning via leveraging real-world applications. To maximise impact, a gender-inclusive pedagogy for teaching STEM, coupled with the prominent presence of female teachers in STEM subjects is crucial.

Research underlines the role of female teachers as key role models, who promote better educational outcomes by demonstrating greater awareness and positive attitudes towards gender equality compared to their male counterparts.[29] High schools and higher secondary sections are seen to have fewer female teachers.[30] Among out-of-school students, the presence of low-quality teachers is a significant factor for dropping out, whereas the absence of female teachers is a key reason for female students.[31]

Addressing pedagogical challenges is crucial for improving students' learning outcomes. This involves enhancing both the capacity and capability of teachers, with a particular focus on making teacher training gender-sensitive to promote inclusive and effective learning outcomes in STEM subjects.

Unveiling the Disparity - 43% of Women Graduate in STEM, But Only 29% Enter the Workforce.

Ensuring women's participation and engagement in STEM education is an important step in the journey from enrollment to graduation. However, it is equally vital to consider the transition from education to the professional sphere, in order to understand and address the unequal representation of women in STEM fields. **Despite 43% of women graduating in STEM[32] courses at the tertiary level, only 29% join the STEM workforce, and most of them are concentrated in the health sector**.[33] To foster greater participation in the workforce, it is essential to create a comprehensive and supportive ecosystem.

The absence of career guidance for progression[34] and a lack of relatable role models act as deterrents for women considering STEM subjects. Insufficient mentorship opportunities restrict the aspirations of young girls, impeding their interest in STEM fields due to a limited understanding of available career paths. This challenge is even more pronounced in rural areas where the presence of relatable role models becomes crucial in shaping aspirations and making "aspirational careers" in STEM seem attainable. Empowering women to make their own decisions is also fundamental, as they often face limited agency when familial and community influences dictate their choices. In addition to empowerment, fostering parental trust and mobilising communities are equally important to enable the translation of women's agency into action.

Gender-insensitive work environments coupled with 'dual role' syndrome present challenges on the participation spectrum. Women scientists often face the pressure to constantly prove their competence while balancing societal expectations of gender roles.[35] This creates a significant cognitive and emotional burden. The challenges of motherhood and limited

> *"Exposure to a science fair/lab alone may not suffice in fostering and maintaining a woman's aspiration to pursue science. A comprehensive ecosystem-level support system for the girl child is essential. This might encompass – localised and relatable role models along with their visible representation; ensuring essential facilities in schools or colleges such as separate and adequate toilets for girls; and accessible public transport (considering schools/colleges are generally located outside the village). Adequate financial assistance through scholarships or opportunities for part-time work or internships during college are also some aspects of a supportive ecosystem. Besides, it is equally important that teaching and learning approaches cultivate curiosity, embrace a multidisciplinary perspective, and integrate students' beliefs and attitudes towards learning, current education, and future career prospects."*
>
> – **Priya Iyer**, Independent Consultant (Education)

mentorship opportunities within male-dominated industries further discourage women's participation in STEM fields. Additionally, the 'dual role' syndrome, in which women's choices regarding their professional paths are significantly impacted by their domestic obligations, hinders their ability to pursue STEM education.[36] 30% of women in science believe that their careers negatively affected family commitments and household responsibilities.[37]

To address these multidimensional challenges, a set of replicable and scalable interventions have been curated to aid the solution ecosystem in enabling women's uptake of STEM education and professions.

Bridging the Gap with Stakeholder Intervention

To attain the desired objectives of retaining women in STEM education, corporate funders and domestic foundations can explore the following interconnected approaches to guide their interventions. The interventions elaborated below have been initiated by non-profit organisations in urban, semi-urban, and rural areas. Although these programmes have achieved success in their respective domains, it is crucial for funders to consider the specific contextual factors that may have facilitated or hindered certain aspects of these interventions.

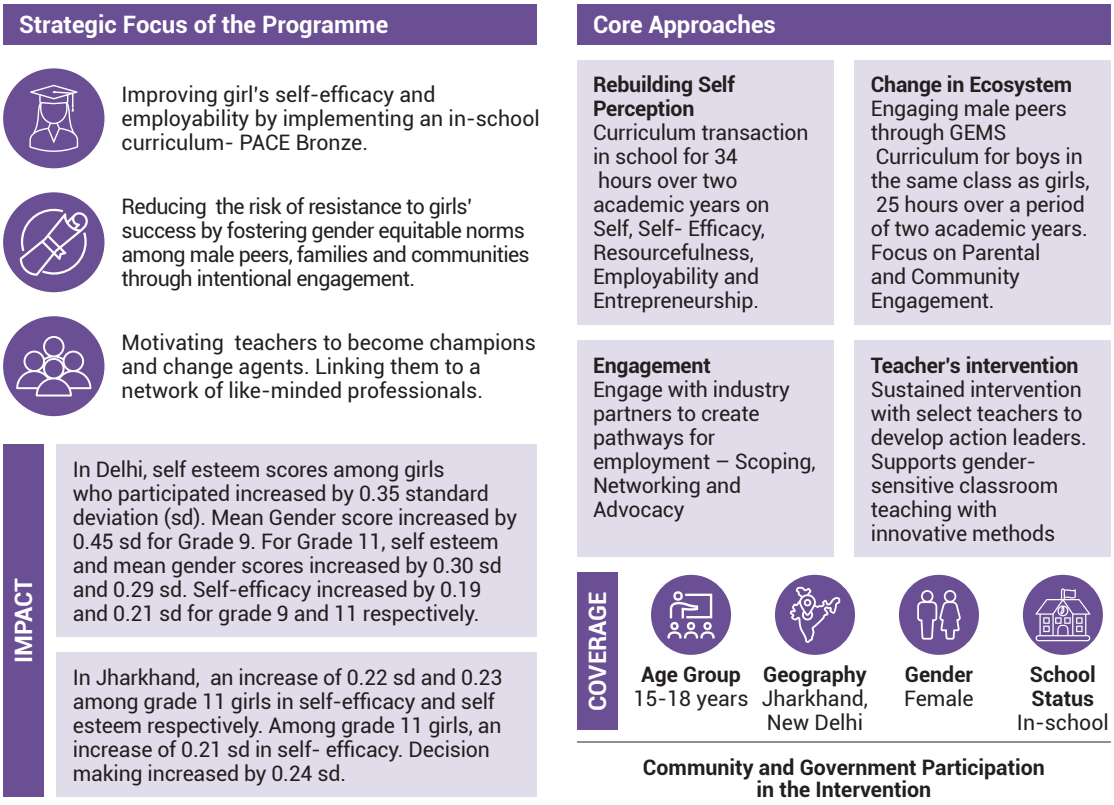
1. Community reforms to empower young girls' education and agency development

Collaborative efforts between the Indian government, private sector, and civil society are essential to implement reforms in education and employment. These reforms focus on encouraging women's engagement in STEM fields, and also highlight the significance of women's participation in the workforce and scientific domains to families and communities.

- **Plan-It Girls**: Shifting the ecosystem to promote girls' agency and employability[38] It is an innovative program empowering adolescent girls by focusing on self-efficacy, employment skills, and challenging gender norms. Through different stakeholder's involvement (adolescent girls and boys, teachers, parents, and community and local institutions) and an ecosystem approach, the program promotes agency and gender equality.

  Shifting girls' self perception, their gender attitudes along with collaboration with key institutions like schools and stakeholders like teachers and parents drives normative change that is an essential condition, while linkages to education, training and employment opportunities ensure long term success.

Figure 6: Plan-It Girls: Shifting the Ecosystem to Promote Girls' Agency and Employability



Source: Plan-It Girls, ICRW

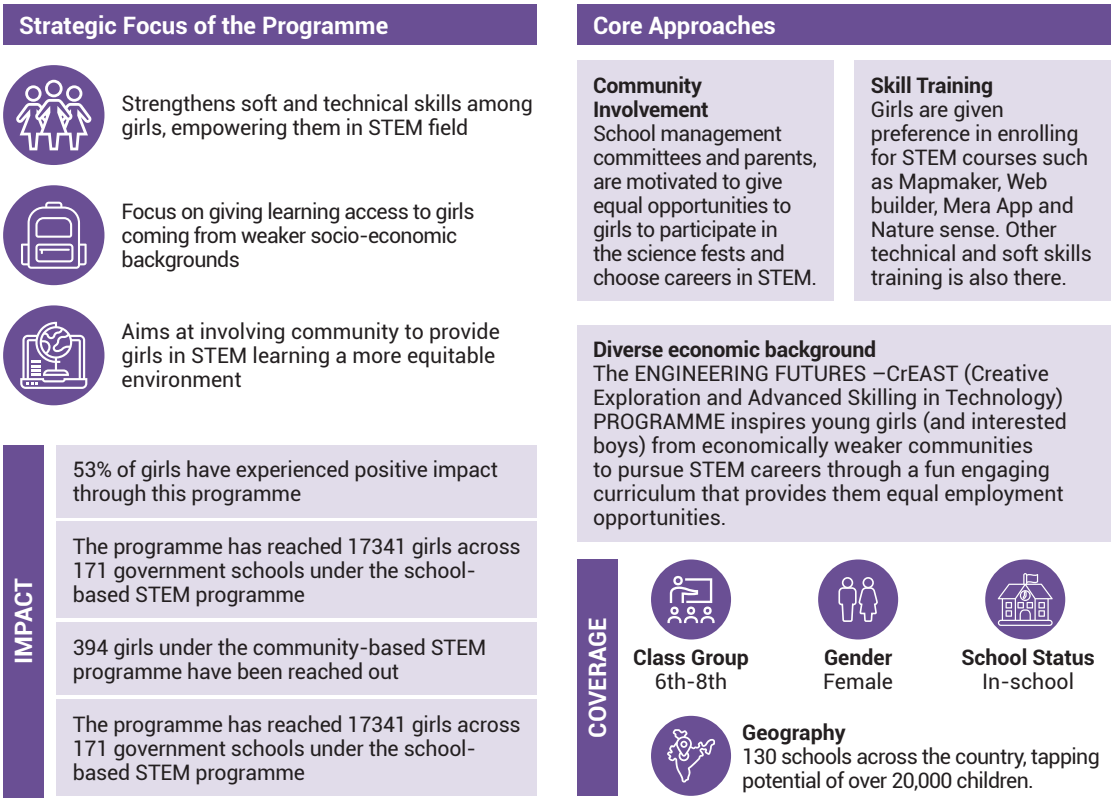
"The formation of identity is influenced by societal norms, family expectations, and systems. Puberty, associated with the reproductive role of girls, significantly impacts their self-identity. The newfound emphasis on their protection and associated restrictions affects their choices, interactions, and education."

– **Dr. Prerna Kumar**, Head-Public Policy, Convergent
(Dr. Prerna Kumar was the director of Plan It Girls at ICRW)

- **Empowering girls in STEM by Larsen & Toubro**[39]: The intervention aims at increasing participation of girls through a set of interventions with school management committees and parents, to change mindsets. By challenging gender stereotypes and biases through inclusive practices and highlighting the achievements of women in STEM fields, an environment that encourages girls' participation in STEM streams is cultivated.

Such multifaceted interventions collectively contribute to bridging the gender gap by providing a holistic approach and enabling an ecosystem that nurtures a diverse and inclusive STEM ecosystem.

Figure 7: Larsen and Toubro focuses on enabling girls through better access to STEM education



Source: Empowering Girls in STEM, L&T Corporate

Collaboration with schools and teachers along family support drives change, while linkages to education and employment opportunities ensure long-term success. Partner organisations and ongoing advocacy efforts ensure sustainability and scalability.

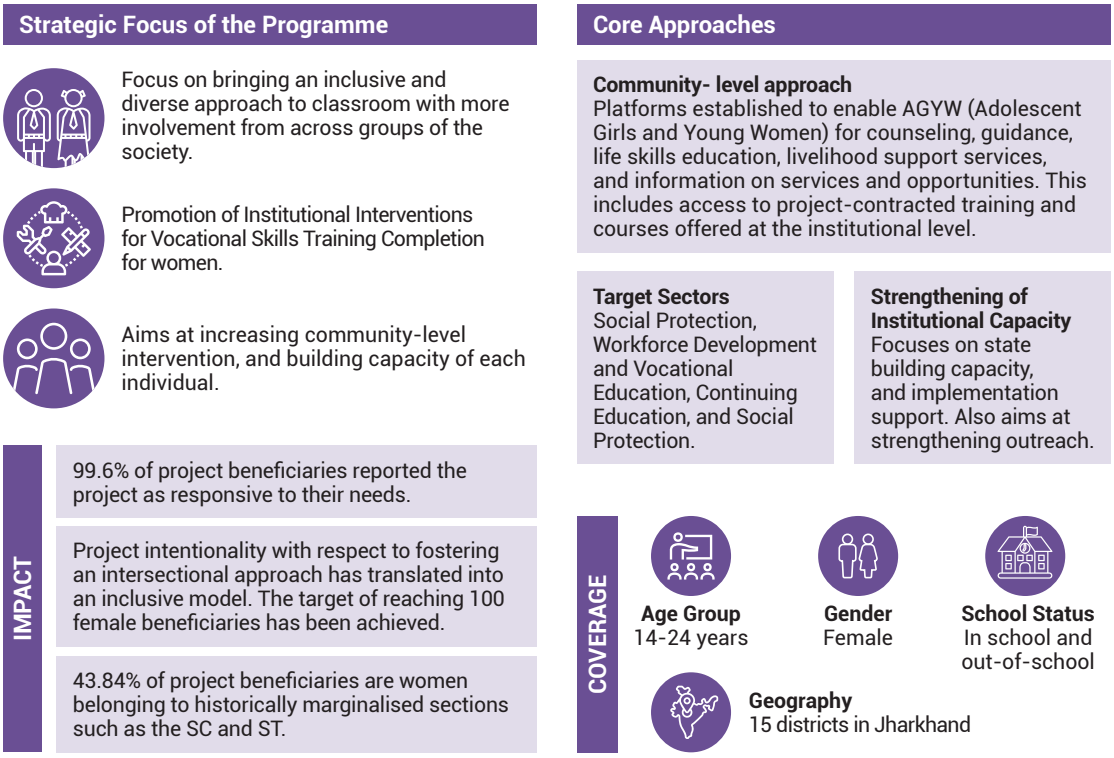
2. Enhancing enrollment, retention and graduation of girls in secondary schools and higher secondary schools

In order to address the persistently high dropout rates among girls in secondary and high schools, it is crucial to prioritise dropout prevention strategies. This requires challenging

traditional gender norms and implementing targeted approaches that cater to the diverse economic backgrounds of girls. Dropout rates can be reduced by actively promoting equal educational opportunities and providing necessary support. Such efforts contribute significantly to achieving the objective of inclusive and equitable education for all.

- **Tejaswini: A World Bank initiative**[40]: The development objective of Tejaswini, for the Socioeconomic Empowerment of Adolescent Girls and Young Women (AGYW) Project in India, sponsored by the World Bank is to improve the completion of market-driven skills training and secondary education for young girls with the focus on expanding social, educational and economic opportunities via a range of interconnected interventions.

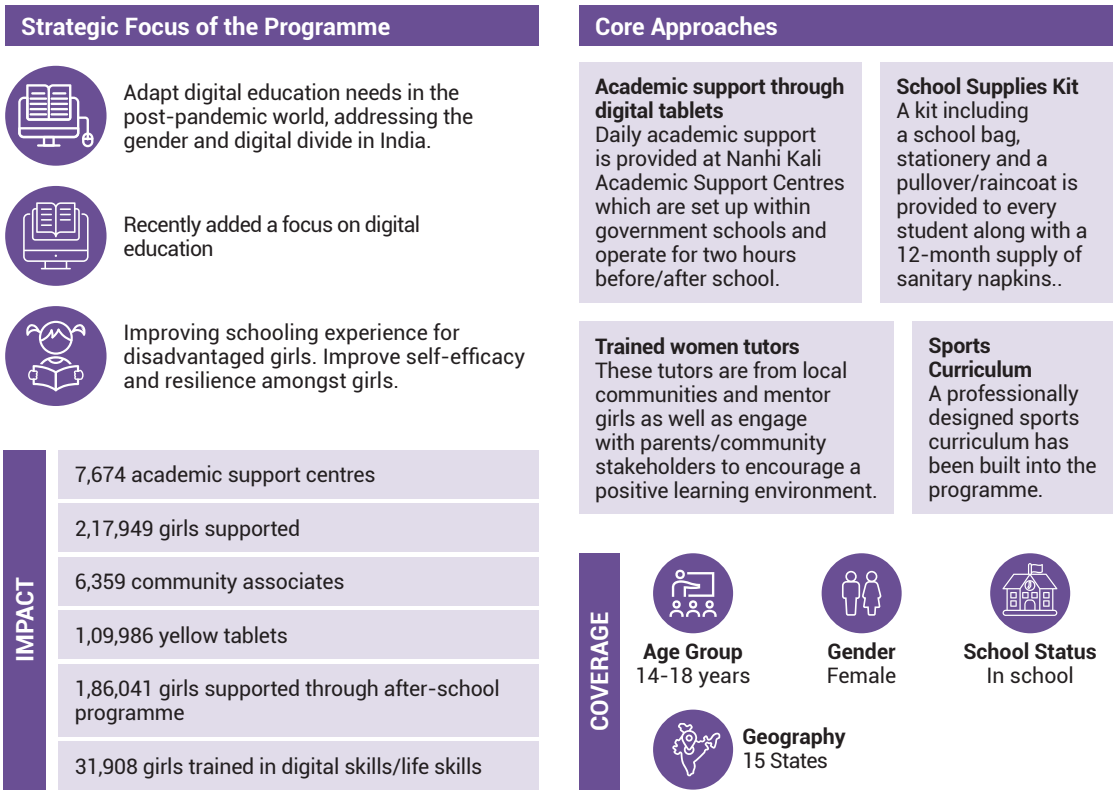
Figure 8: Tejaswini aims to enhance market-driven skills training and secondary education completion for AGYW aged 14-24 in 15 selected districts of Jharkhand.



Source: Tejaswini, Socioeconomic Empowerment of Adolescent Girls and Young Women

- **Nanhi Kali**[41]: Project Nanhi Kali by the KC Mahindra Education Trust has been conceived with the aim of supporting the education of underprivileged girls in India. The programme has directed its focus on digitally enabled education in the post-pandemic world where "negative consequences of gender divide are aggravated by the pervasive digital divide in India."

Figure 9: Project Nanhi Kali aims to support the education of underprivileged girls in India from low-income families.



Source: Nanhi Kali, Mahindra Foundation

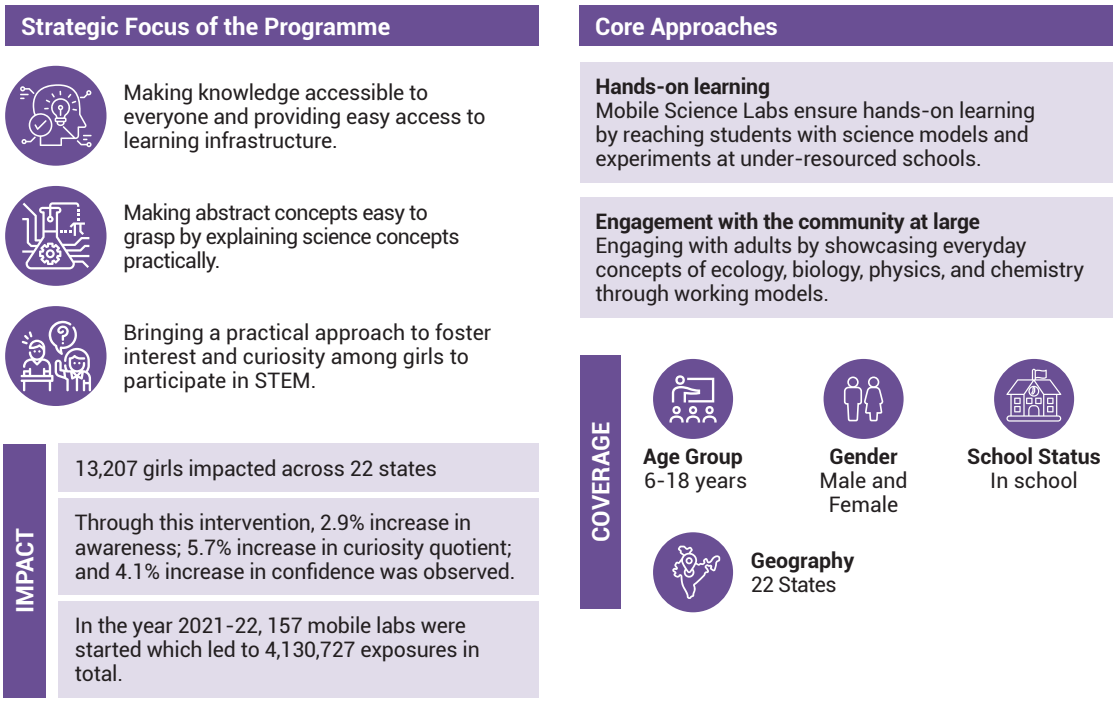
Investing in girls' education at this stage leads to the creation of several pathways for their personal growth which help break the cycle of poverty. Additionally, by reducing child marriages and early pregnancies, they contribute to overall social development.

3. Solving for inequitable access to infrastructure

The challenges associated with limited access to adequate educational infrastructure can significantly impact the quality of education. Therefore, it is essential to prioritise efforts that emphasise affordable and accessible solutions to ensure that all individuals have the opportunity to access quality education.

- **Mobile ScienceLab, Agastya Foundation**[42]: These mobile vans are well-equipped to solve schools' lack of access to quality labs without compromising on students' learning experiences. With the goal of enhancing accessibility to learning resources, these mobile science labs, equipped with science models and experiments, traverse long distances to reach students at under-resourced schools. They are accompanied by two instructors who enable hands-on learning for students.

Figure 10: Mobile Science Lab by Agastya Foundation solve schools' lack of access to quality labs without compromising on students' learning experiences.



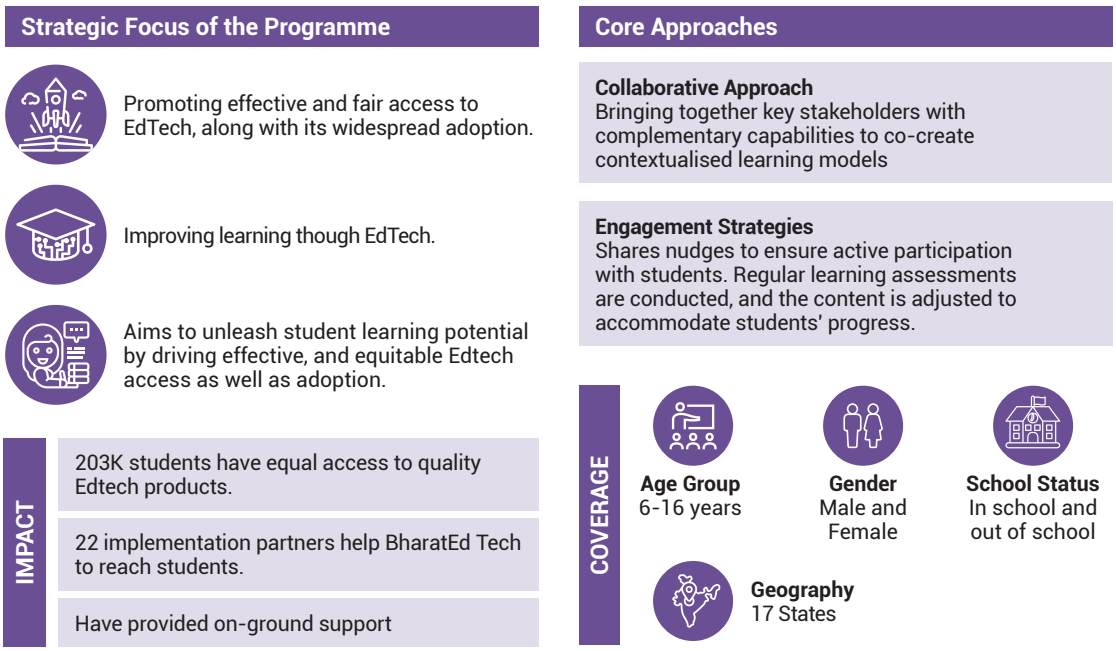
Source: Mobile Science E Labs, Agastya Foundation

A similar initiative is undertaken by Pratham"s Vigyan Mitra, which has been running for the past fifteen years. It works towards building curiosity and love for science amongst middle school students in remote rural areas. Local girls and boys are trained to become 'Vigyan Mitra' (friends of science), and enable hands-on learning through small experiments, science kits etc. amongst community and children in school, thereby fostering curiosity in science.

> *"If we are able to show rural girls career opportunities associated with science , which they can achieve, the girls will definitely come forward to take up science."*
>
> - **Jayashree Mane**, Pratham

- **Bharat Edtech Initiative**[43]: It aims to ensure equitable access to digital learning among low-income households, with a focus on addressing the digital divide based on income and gender in India.

Figure 11: The Bharat EdTech Initiative aims to provide equitable access to digital learning among low-income households, with a special focus on income and gender-based digital divide

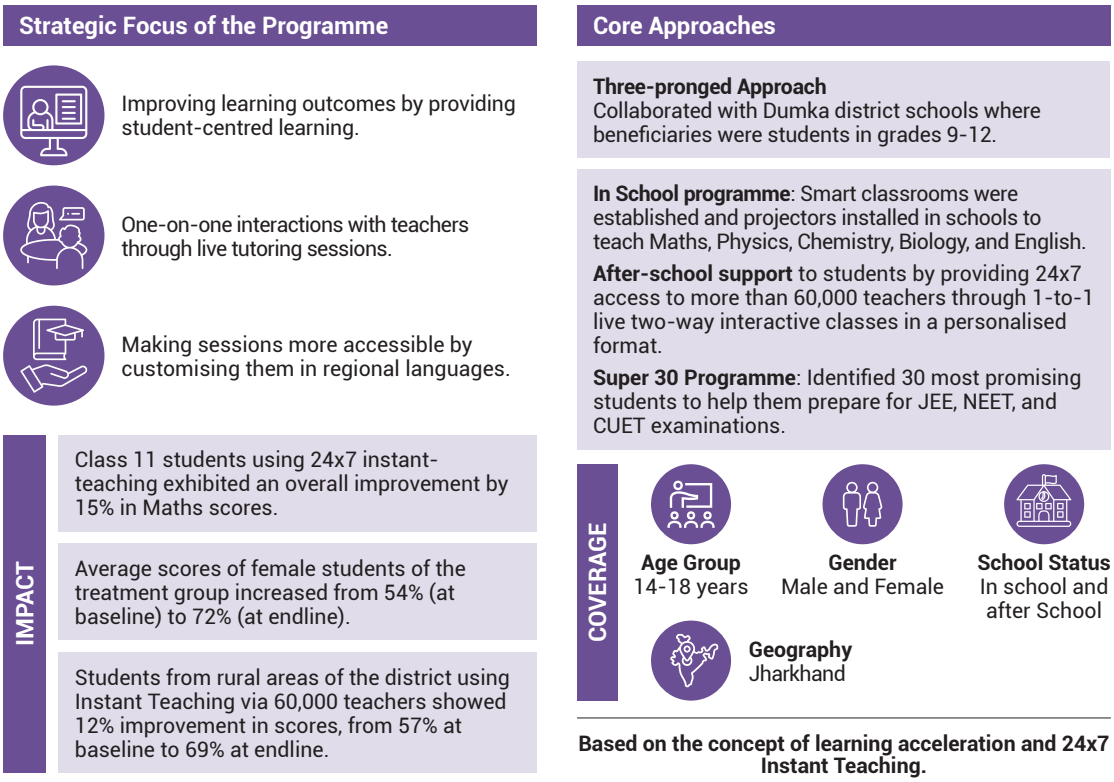


Source: Bharat EdTech Initiative

- **Filo**: It is an innovative ed-tech start-up that aims to address student's learning gaps by providing personalised and adaptive education through technology based intervention. It is implemented in collaboration with the district of Dumka, Jharkhand for students in grades 9-12.[44] The idea of providing a subject teacher through a tech-based intervention as and when the student needs it was well-received by government school students in Dumka. The intervention's ability to expand and endure is effortless due to its technological nature, allowing for quick replication on a large scale, while still meeting the specific linguistic requirements across geographies with respect to higher secondary STEM students.

> *"This project has the potential for scalability to various remote rural areas with limited internet connectivity. One of the key advantages is its adaptability to different dialects, enabling customisation based on local language variations. Our study indicates that girls possess a remarkable level of sincerity, and when provided with suitable opportunities, they demonstrate exceptional abilities and excel in their endeavours."*
>
> – **Rohit Kumar,** Co Founder, Filo

Figure 12: Filo's Sampurna Shiksha Kavach Programme



Source: Sampurna Shiksha Kavach, Filo

Addressing the issue of inequitable access to infrastructure in India is paramount for promoting girls' participation in STEM fields. Adequate infrastructure – encompassing reliable electricity, internet connectivity, well-equipped laboratories, and educational resources – is fundamental for quality STEM education. By prioritising and resolving infrastructure gaps, ensuring equal access for all, and implementing inclusive policies, a more level playing field can be established. This, in turn, will provide girls with the necessary tools and opportunities to pursue STEM education and careers.

4. Fostering curiosity with a focus on girls' interest and enrollment in STEM

Introducing innovative teaching methods and enhancing teachers' capacity is accompanied by a noticeable rise in girls' interest in STEM fields. Equipping teachers with the necessary skills and resources enables them to create engaging learning environments that inspire students to explore and excel in science, technology, engineering, and mathematics. This holistic approach strengthens girls' educational journeys and empowers them to pursue their passions with confidence. Atal Tinkering Labs[45], established in Kasturba Gandhi Balika Vidyalayas (residential schools for girls in remote areas) is one of many such interventions that the Government has brought in to foster curiosity, creativity, and imagination in young minds; and inculcate skills such as design mindset, computational thinking, adaptive learning, and physical computing. Around 10,000 such labs, engaging with 75 lakh students function in India through the Public Private Partnership (PPP) model.

- **CARE India**[46]: Its STEM education projects promote critical thinking skills and adaptability. As teachers play an important role in the uptake of STEM streams for adolescents, initiatives like the Teacher Resource Laboratory (TRL) established in Uttar Pradesh and Innovator's Laboratory in Bengaluru support teachers to integrate research and problem-solving into the curriculum.

> *"I was talking to another teacher the other day, and they brought up a thought-provoking example. They mentioned how, when checking attendance, they tend to rely on the boys' counting more than the girls'. This small observation reflects the larger issue of how girls might perceive their competence and worth in STEM subjects. At CARE, we are passionate about addressing these micro-level biases and subconscious nudges in the classroom. Our goal is to empower teachers to create a gender-sensitive learning environment that boosts the confidence of young girls in STEM."*
>
> – **Priyanka Saxena**, CARE India

Adolescent girls require intensive and structured support to be groomed as innovators and future social change makers. To achieve this, CARE India has designed school- and community-based projects aimed at building in adolescent girls the necessary knowledge, skills and aptitudes, and emotional resilience to help them engage with societal challenges as leaders.

Figure 13: STEM labs: Building the capacity of teachers to encourage girls to pursue STEM

Strategic Focus of the Programme

- Gender equality, socio-emotional wellbeing of students and community level engagement.
- Building emotional resilience in middle school students and enabling them to become social change leaders.
- Enabling teachers with adequate support to be able to build research and thinking skills and curiosity towards STEM in students.

IMPACT

- STEM laboratories impacted more than 7,000 children and more than 200 educators in the year 2019-20 in Tamil Nadu and Uttar Pradesh.
- Children in 4,500+ schools and special training centres across 6 states benefited through 11 education projects.
- Girls were provided leadership platforms through strengthened capacities of KGBV and upper primary school teachers in Haryana.

Core Approaches

Teacher Resources
Enabling teachers with adequate support in the form of Teachers' Resource Laboratories (TRLs) and allied infrastructure, experiment table, books, Science and Math kits and other aids.

Specialised Laboratoriess
Establishing laboratories equipped with experiential learning equipment, reference material, and digital devices to serve as STEM learning centres for middle school children and educators.

Girls' Leadership Model
CARE India has designed school-based and community-based projects aimed at imparting adolescent girls the necessary knowledge, skills and aptitudes, and emotional resilience to help them engage with societal challenges as leaders.

COVERAGE

Age Group
15-20 years

Gender
Female

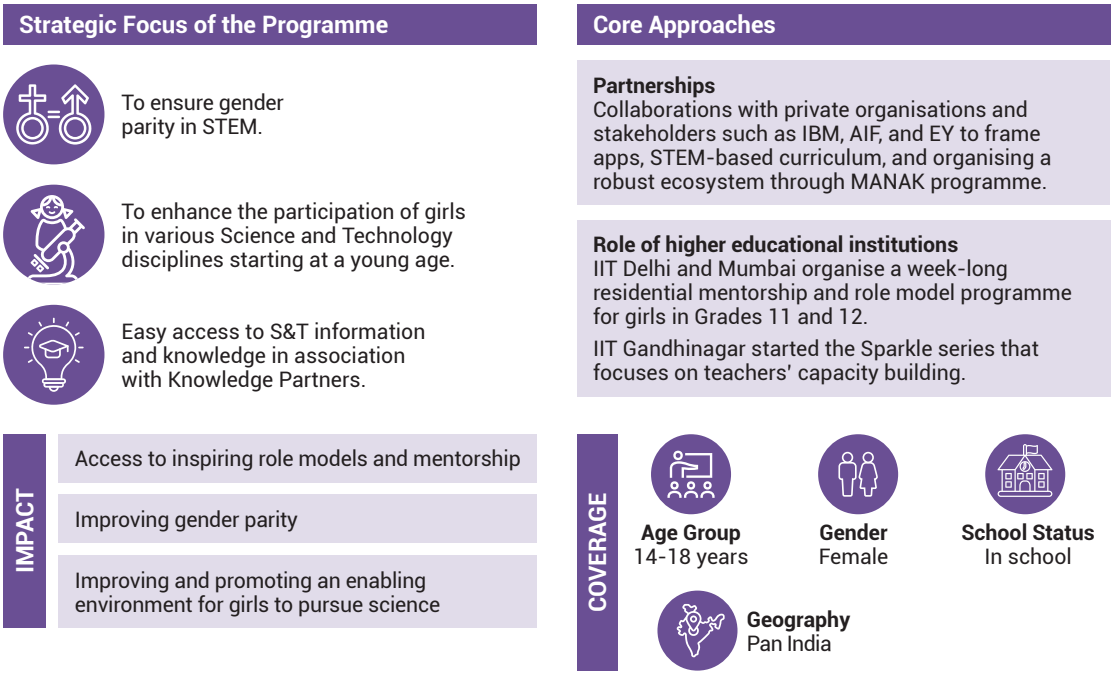
School Status
In school

Geography
21 States

Source: STEM Laboratories, CARE India

- **Vigyan Jyoti**[47]: Vigyan Jyoti addresses the underrepresentation of young girls and women in STEM by providing girls in Navodaya Schools access to inspiring role models in STEM professions. This is done through industrial partnerships and collaborations with centres of Higher Education (IITs) in STEM.

Figure 14: The Vigyan Jyoti programme addresses underrepresentation of women in STEM by encouraging exemplary performers to pursue science in higher studies and careers



Source: Vigyan Jyoti

Vigyan Jyoti is an interesting example of the central government building partnerships with tech giants like EY and American India Foundation.

To foster curiosity in STEM among girls, we need innovative and inclusive teaching methods. Their engagement with the disciplines can also be enhanced by nurturing curiosity and empowering girls to challenge norms, think critically, and develop confidence. Role models also play a vital role in inspiring girls and sparking their interest in STEM fields. These efforts aim to increase representation and achievements, fostering a diverse and inclusive STEM community.

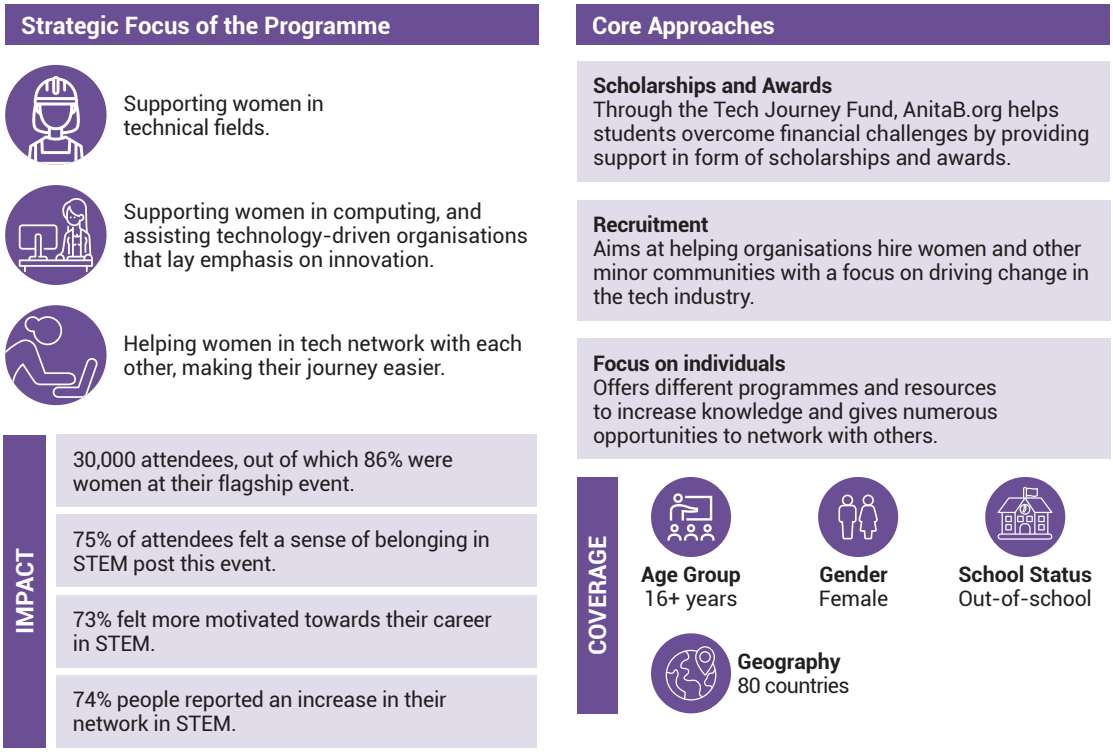
The deliberate promotion of curiosity empowers girls to question societal norms, cultivate critical thinking abilities, and strengthen their confidence and self-efficacy. Moreover, by fostering curiosity, a lifelong passion for learning is cultivated, thereby enabling girls to sustain their engagement in STEM disciplines beyond formal education. By recognising the pivotal role of curiosity in girls' enrollment in STEM, educational stakeholders can create conducive environments that stimulate exploration, ignite intellectual curiosity, and ultimately bolster the representation and achievements of girls in these domains.

5. Enabling School to Work transition

Interventions are in place to promote STEM education among girls and cultivate students' curiosity in STEM subjects, beginning from middle school. Additionally, it is crucial to focus on retaining women in STEM fields by facilitating a seamless transition from school to work in STEM-related careers.

- **AnitaB.org**[48]: AnitaB.org is a non-profit organisation that provides a range of services to enable women in STEM careers to enter, continue and succeed in the space. A full roster of programmes helps women and non-binary technologists grow, learn, and develop their highest potential.

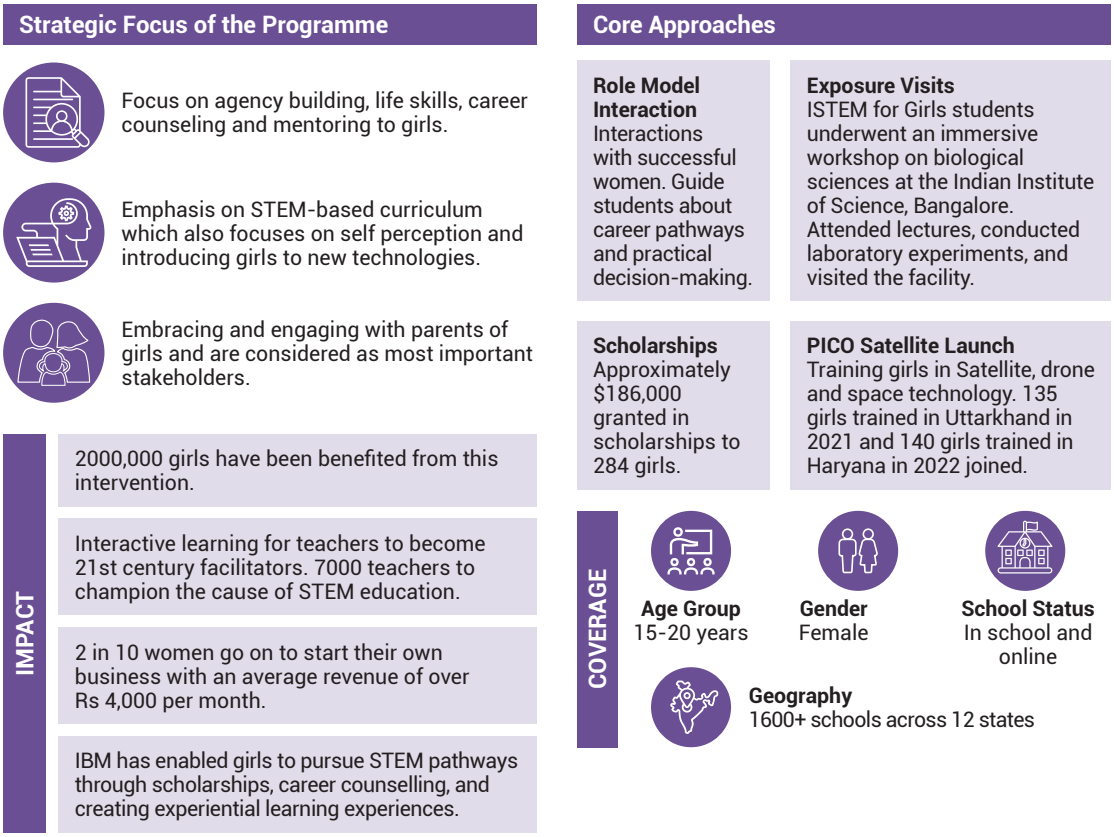
Figure 15: AnitaB.org empowers women and non-binary technologists to reach their full potential through growth, learning, and development



Source: AnitaB.org

- **IBM STEM for Girls**[49]: IBM's STEM for Girls initiative aims to address the disparity in India's STEM workforce, of which only 14% are women, compared to the global average of 28%. The programme is currently operational in 12 states across India. The vision behind this initiative is to enhance school curricula by integrating life skills such as problem-solving, critical thinking, and entrepreneurship. Instead of solely focusing on coding languages and following trends, the programme emphasises practical hands-on work to foster conceptual understanding and problem-solving strategies. These programmes help girls to amplify their understanding and help develop necessary negotiating skills.

Figure 16: STEM for Girls: IBM initiative to improve education and career pathways for girls in schools



Source: STEM for Girls, IBM

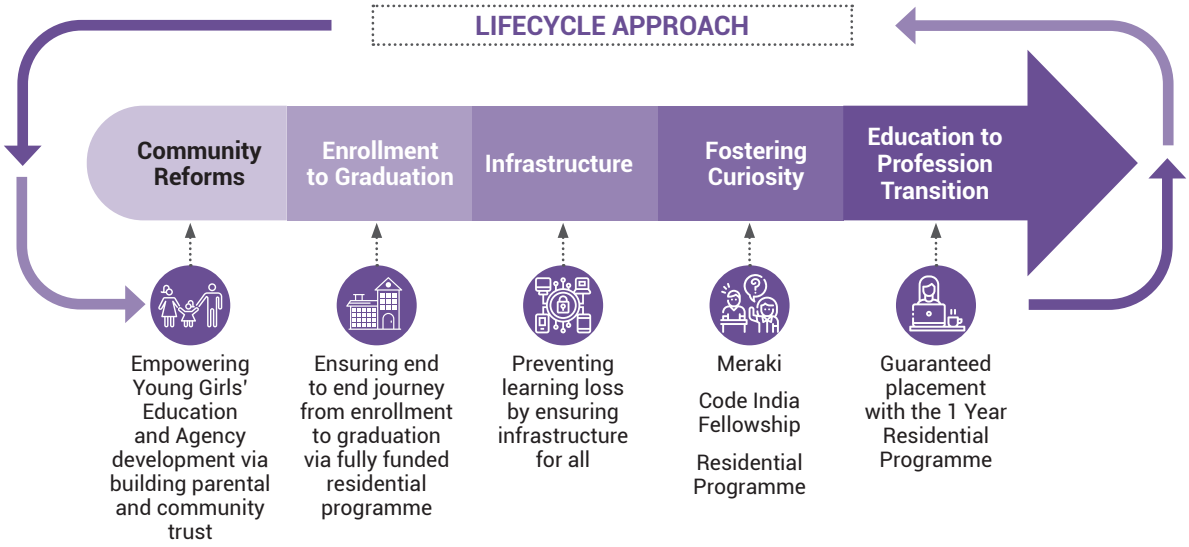
"There is much more work ahead but by fomenting a STEM mindset and expanding possibility, we hope to shape the education and careers of women, by starting with our girls".

– **Jasbir Kaur**, **Neha Patri** & **Afrooz S**.

Lifecycle Approach for Comprehensive and Holistic Impact

While existing interventions may address specific aspects of the challenge in isolation, they often yield limited impact in the long run. A lifecycle approach plays a crucial role in enabling and retaining women's participation in STEM. It recognises the complex and interconnected challenges that hinder women's engagement in STEM fields. By adopting a lifecycle approach that comprehensively addresses barriers at different stages, more holistic and effective outcomes can be achieved for the target population.

Figure 17: A Case Study of Navgurukul[50]: Lifecycle Solution to Lifecycle Problem



Source: Sattva Analysis

NavGurukul, founded in 2016, has a mission to improve the socio-economic prospects of marginalised and excluded communities in India by providing high-quality education. Their primary initiative is their residential program anchored in a self-paced pedagogy with a focus on teaching software coding to underprivileged youth. This program follows a lifecycle model, targeting a critical stage in individuals' lives where they are at risk of becoming disconnected from formal education.

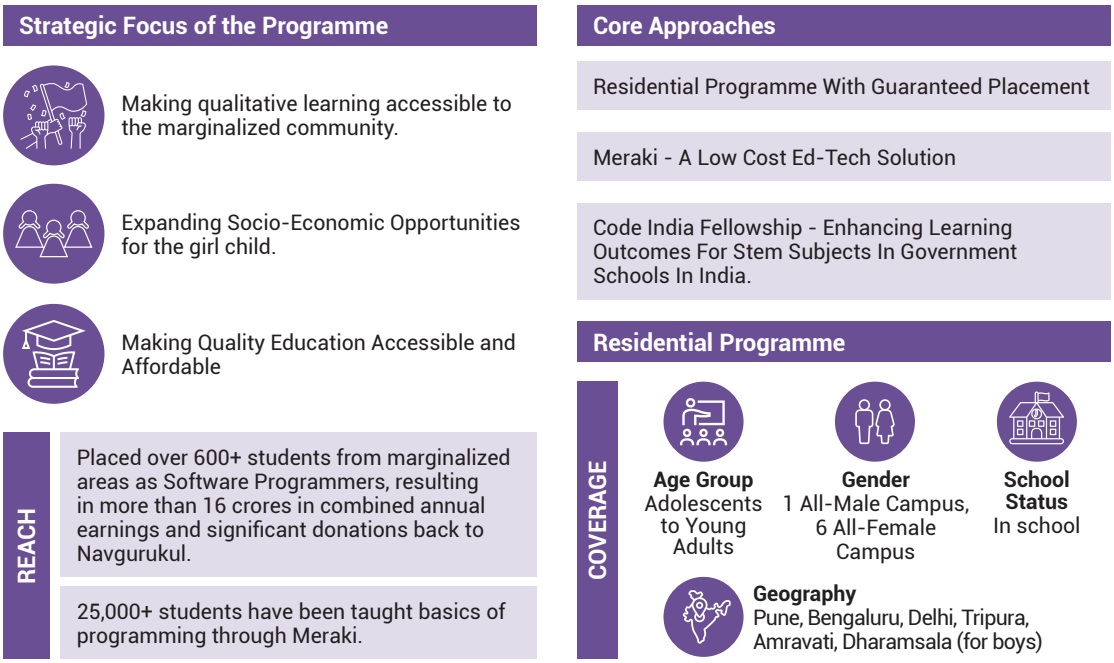
With six out of seven campuses exclusively dedicated to girls, NavGurukul recognises the importance of building community connections and trust with guardians to facilitate girl enrollment. NavGurukul enhances its community engagement by establishing partnerships with various NGOs and organisations that collaborate with diverse communities. Additionally, it collaborates with the government to actively engage specific target demographic groups.

Simultaneously, it also prioritises empowering female students by providing them with a range of soft skills, enabling them to make informed decisions. The program ensures a comprehensive journey from enrollment to graduation by offering a fully-funded residential approach to teaching that addresses challenges related to accessibility and affordability for all students.

To ensure uninterrupted learning, NavGurukul provides functional laptops and internet access to each student, addressing the learning gaps caused by unequal access to infrastructure. The immersive nature of the residential program, coupled with innovative teaching methods, promotes accelerated learning for the youth. Alongside the residential programs, NavGurukul achieves enhanced learning outcomes in STEM subjects through two additional interventions: **Meraki and Code India Fellowship**. Meraki is a hybrid ed-tech solution that offers affordable online tech education to students from low-income families across India. The Code India Fellowship, on the other hand, recruits highly capable young

tech graduates for a one-year fellowship. These fellows are then placed in government high schools to improve the learning outcomes of students from classes 8 to 12, with a particular focus on young women. Ultimately, NavGurukul ensures a holistic journey for its students by providing job placement opportunities at the end of the one-year residential fellowship.

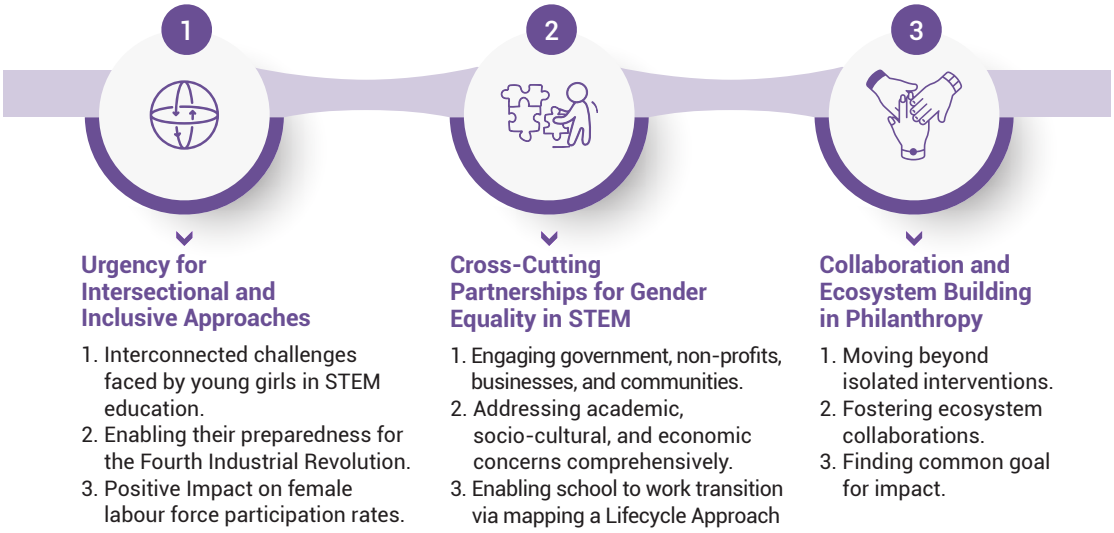
Figure 18: Navgurukul



Source: Navgurukul

Way Forward: Nurturing Collaborative and Inclusive Alliances for Empowering Young Girls in STEM

Figure 19



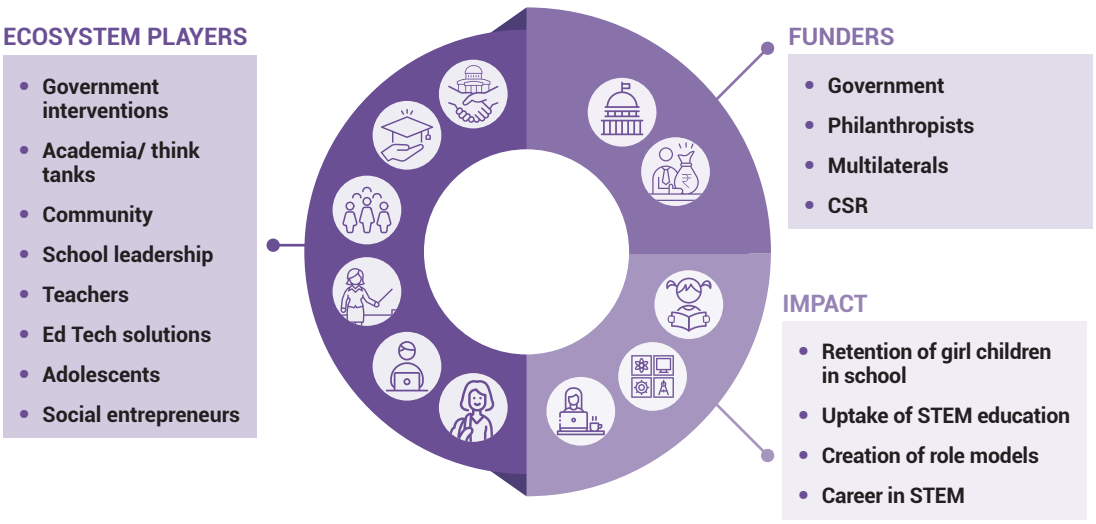
Source: Sattva Analysis

As young girls remain missing data points[51] in the journey from STEM education to STEM professions due to structural, social and personal barriers, it is crucial that an intersectional and inclusive approach be embedded in solutions for enabling enrollment and retention of young girls. This need becomes even more urgent due to ongoing efforts to rebuild the educational system after the pandemic, which provides an opportunity to address the gender disparity in STEM learning. Additionally, the emergence of the Fourth Industrial Revolution, with its emphasis on digital jobs, further highlights the importance of the intervention. Without timely action, women will be left behind, perpetuating the current concerns regarding low female labour force participation rates.

Domestic philanthropy has been an enthusiastic participant in solving the many challenges of the educational landscape. For instance, the KC Mahindra Education Trust with its Nanhi Kali intervention has incorporated digital learning as a key module for young girls. Similarly, Agastya Foundation with their mobile buses and Vigyan Mitra of Pratham are enabling access to infrastructure in face of resource crunch. However, these interventions, while bringing in positive impact, solve only specific voids in the educational landscape when it comes to engendering STEM education. Given the polycritical nature of challenges, it is crucial to move beyond isolated interventions and foster ecosystem collaborations that can meaningfully and effectively address the various pieces of the education puzzle.

To promote gender equality and encourage young women in STEM, cross-cutting partnerships leading to common goal led collaboratives are essential. These collaborations involve government agencies, academic institutions, nonprofits, businesses, and civil society working with communities, teachers, school leaders, adolescents etc. all coming together to overcome barriers that hinder girls' success in STEM. Integrated programmes can address

Figure 20: Framework for Cross-cutting Partnership



Source: Sattva Analysis

academic, socio-cultural, and economic concerns through collective resources, expertise, and information. Multifaceted collaborations offer holistic support for girls, while industry-education partnerships improve STEM standards and relevance. Practical experiences, access to facilities, and industry-academia alliances bridge the gap between classroom learning and career requirements, facilitating a smoother transition for girls pursuing STEM.

In the philanthropic realm[52], there is a growing recognition of the interconnectedness of impact areas, prompting a necessary adjustment in approaches. However, this shift is accompanied by the challenge of identifying and prioritising intersecting impact areas within the complex educational landscape. One particular area of contention arises when determining the role of education: whether it should be perceived as an end goal in itself or as a means to achieve broader outcomes. This distinction holds significant implications for funding principles. **To drive progress effectively, it is vital to foster alignment and crosscutting partnerships that bridge these perspectives**. By bringing together stakeholders with diverse viewpoints and expertise, a more comprehensive approach can be taken to address the multifaceted crises facing the enrollment, retention and graduation of young girls in the STEM education space. Collaboration and a holistic mindset are essential in navigating the multifaceted and engendered obstacles that young girls encounter in achieving sustainable and long-lasting impact.

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