ELEVATE
A LEARNING TOOL FOR SPECIAL NEEDS CHILDREN

SUBMISSION FOR
GENEVA CHALLENGE
2020
The last decade has witnessed a revolution in human centric design. Research in artificial intelligence and machine learning has enabled policy makers to enhance legislative outcomes. In the education sector, these technologies are increasingly being used as an aid to traditionalist methods in order to provide an efficient learning pathway to students. However, there exists a lacuna in the reach of such interventions for special needs students, who often require individualized attention and adaptive curricula to match their cognitive skills. Additionally, policy frameworks rarely target the cognitive growth of these children, and the lack of recent data acts as a restraint to the creation of updated policies. To achieve the overarching aim of social inclusion, it is important to make high-impact changes at the grassroots level, in order to enable individuals to realize their potential and translate it into suitable opportunities.

Our solution, "Elevate", is a virtual classroom for special needs students. Relying on adaptive learning and knowledge tracing algorithms, Elevate leverages user data to generate personalized curricula for students. It tracks student progress and operates through a feedback loop to ensure that learning takes place in a customized manner and in concordance with the child’s cognitive abilities. It also enables schools and organizations to use live data insights to create processes that enable learners to take advantage of the education system and thus generate positive long term benefits. Elevate is created keeping each child’s uniqueness in mind, and ensures that differences never serve as impediments within the education system.

MEET THE TEAM

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MOTIVATION

Running over our laptops keyboard our fingers seamlessly move over two subtle bumps. Right on the letters F and J were two lifted lines deformities hiding in ‘plane’ sight. Curious, we jolted upright and tried to find the purpose. One search was enough to keep us awake. For most they help orient their hands without looking down. For us, however, their application for the visually impaired was suddenly clear. These two bumps signify a seamless integration of features without serving as an impediment to others. They represent equity for so much more than just creating exceptions in our daily lives to accommodate minorities. F and J prove that genuine equity demands mainstreaming by recognizing but not reiterating inherent differences between individuals. With this motivation, we seek to approach education policy design through an alternate perspective, by combining social psychology with human centered design to ensure that each student eventually becomes a learner.
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Recent policy trends pertaining to education, especially in developing countries, have been gravitating towards the United Nations’ Sustainable Development Goal (SDG) 4, which aims to ensure inclusive and equitable education for all, along with promoting life-long learning (United Nations). Developing countries have followed suit: new policies are being implemented across the world, governments are increasing budgetary allocation towards education and the job market is providing incentives for people to improve their skills. However, the response of local and national governments alike is unidimensional in nature; while an increase in educational access is enabling students across the globe to leverage new opportunities, children with special needs still lack a targeted intervention aimed to improve their cognitive abilities.

Among children with disabilities, those with "mental retardation and mental disabilities" report the lowest attendance at schools (India Today Web Desk, 2019). More so, within this category of students, there exists stark gender disparity—while 56% of boys between six and fourteen attend school, only 44% of girls in the same age bracket do so (India Today Web Desk, 2019). Even with one of the most vast education systems in the world, with over 1.5 million schools and 260 million students (World Educational Services), there has been no notable integration of children with special needs into the existing education infrastructure. Another impediment to more insightful research into this subject is the lack of recent data, the latest belonging to the 2011 Indian Census, further hampering good public policy making.

The importance of technological interventions in educational policy making has long been recognized by the Indian government. A combination of human centered technology and standard teaching practices can help elevate the learning experiences, expectations and eventual outcomes of special needs children multifold. This is what Elevate, our adaptive learning tool aims to achieve - Leveraging the accessibility and power of technological advancement and combining it with well grounded research on learning disabilities, to enable policy makers and institutions streamline their resources towards ensuring that this segment of learners is not left behind.

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UNDERSTANDING LEARNING DISABILITY

Children with learning disabilities experience difficulty in adapting new skills such as reading, writing and personal care, when compared to the average individual (Mental Health Foundation, nd). Vygotsky (Vygotsky, 1978 as cited in Suleymanov, 2015) posited that disability is viewed as a challenge not on its own, but when seen in relation to other non-disabled individuals in a social context, thus bringing forth the sociological nature of disability and its ties with social exclusion. Children with learning disabilities experience stunted cognitive growth not only due to their impairments but also due to the restraints in having access to basic social needs such as education (Innocenti Research Centre, 2007). This “social model of disability” (Innocenti Research Centre, 2007) that shifts focus from the individual’s limitations to the environment’s constraints, emphasises on the discrimination against the disabled. The preconceived notion about the excessively limiting nature of learning disabilities prevents many schools from admitting the children (Polat, Adiguzel & Akgun, 2012), which leaves them with bleak prospects of work in the future and further makes it difficult to lead normal lives. The inability to find employment results in lack of financial resources to seek medical help, which contributes to extending the incidence and impact of disability.

Due to lack of education and poor employment prospects, the possibility of slipping into poverty increases (Innocenti Research Centre, 2007), furthering discrimination due to social stratification (UNICEF & WHO, nd). This leads to a dependency of children with disabilities throughout their lives (UNICEF & WHO, nd), which reduces the probability of becoming self-sustaining individuals during their adulthood.
In the larger macroeconomic context, the restricted access to education also entails adverse impact on the country’s economy, such as the reduction of demographic dividends. The young population of individuals with disabilities may never get the opportunity to actively work in formal employment sectors and contribute to the growth of the economy. Subsequently, they may excessively rely on other people's income, especially in countries with a weak social security net, thereby not being able to optimize their own potential and be self-sufficient.

At the same time, research notes that the additional care demanded by children with disabilities, may unfortunately force the lesser earning members of the family to give up their jobs and cater to the child with special needs, hence reducing the household income level (UNICEF & WHO, nd). In fact, UNICEF & WHO (nd) observed that siblings of disabled children in rural areas often drop out of school to provide care to the child, hence taking away their opportunity to study as well. Similarly, the high cost of treating learning disabilities, often incurred by households, may drain families off their savings and force them into poverty (UNICEF & WHO, nd). Therefore, these factors lead to a vicious cycle of the special needs child being discriminated against, which prevents them from getting an education and social life. Without these, the child does not have the means to outgrow their limitations imposed by their disability, in turn keeping them restrained without any opportunity to live a more fulfilling life. Therefore it becomes important to use education as a tool to ensure that special needs children get their due.
SPECIAL NEEDS REQUIRE SPECIAL POLICIES: HOW HAS INDIA FARED?

In order to overcome the barrier presented by disabilities, the Indian government has historically passed several legislations with the objective of integrating children with disabilities into the mainstream category. The following are major legislations that have significantly impacted special needs education in India:

1. **Rehabilitation Council of India Act (1992)** states that Children With Special Needs (CWSN) will be taught by a trained teacher.
2. **Persons with Disabilities Act (1995)** ensures educational entitlement for all children with special needs up to 18 years in an appropriate environment.
3. **National Trust Act (1999)** necessitates the provision of services and support to severely disabled children.
4. **The 86th Constitutional Amendment (2007)** maintains free and compulsory education to children, up to 14 years.

![Diagram](source: generated by authors)
While this may seem like a proactive approach on the surface, a deeper look reveals inherent fractures with regard to efficient implementation of these laws. The scope of these laws is limited and existing mechanisms do not incorporate specific frameworks for special needs children. Therefore, the lacuna in effective implementation and streamlining resources towards better access needs to be addressed.

The state machinery has formalized various regulations to improve educational access for economically backward students. For instance, the Draft New Education Policy (2016) was a major legislation which proposed a significant number of changes in the education system and framework. It was noted that technology plays an important role in providing the classroom process of teaching, learning evaluation and aiding the teachers in the process through professional development of teachers. It recognizes and hence recommends electrification of educational systems to increase access to technology based interventions. However, the law does not recommend alternative pathways to incorporate special needs curricula into a tech-based learning environment.

The legal mandates have also helped shape the comprehensive National Action Plan for Inclusion in Education of the Children and Persons with Disabilities (MHRD, 2005), and the National Policy for Persons with Disabilities (2006). While policy circles consider India’s disability frameworks as some of the most progressive in the East, a multidimensional view would increase access even further. A re-examination of these frameworks would aid policy makers in evaluating the accrued benefits of specific interventions. (UNESCO, 2009)

In order to put the research regarding disability and education in a larger context, there has been a surge in global literature on the impact of Early Childhood Education (ECE) on long run socio-economic performances of individuals; however, there is a scant focus on education specifically for those with special needs. For instance, the landmark Coleman Report (1966) shed light on the weak correlation between teacher attainment and student test scores. It suggested alternate policy instruments including reducing student-teacher ratios, increasing resources and creating incentive structures which would, in turn, translate into more equitable short term and long term student outcomes. Childhood development programs such as the Perry Preschool Project and Head Start in the United States have shown positive impacts for treated students, ranging from better test scores, reduced teen pregnancy and lowered probability of criminal activities amongst low income children. They have led to a series of interventions across the United States, aimed at improving long run development outcomes. However, only 15% of the program schools within the Perry Preschool Project focused on special education. (Wilson, 2000).
<table>
<thead>
<tr>
<th>PROGRAMS</th>
<th>MEASURES</th>
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<tbody>
<tr>
<td>Integrated Education for Disabled Children (IEDC) scheme initially launched in 1974, and subsequently revised in 1992</td>
<td>Aids and improves teacher processes by contributing towards salaries, training, improving school architecture, providing learning materials and initiating community mobilization.</td>
</tr>
<tr>
<td>India’s Signatory Status to Salamanca Statement (UNESCO, 1994)</td>
<td>It resulted in a rapid incorporation of the term ‘inclusive education’ in various official documents and reports published by institutions such as the NCERT and media.</td>
</tr>
<tr>
<td>Sarva Siksha Abhiyan</td>
<td>It highlights the concerns of special needs children and includes them in the framework of &quot;inclusive education&quot;, thereby including this section of learners in the overarching aim of universalizing elementary education.</td>
</tr>
</tbody>
</table>

Table 1: Major Policy Developments in Special Education in India
In the Indian context, the analysis of two government reports - the Kothari Commission produced in 1964 and the Sargent Report produced in 1944 describe the historically dual approach that the government has taken towards people with disabilities. Both these reports stressed the need to expand special and integrated facilities. This dual approach continued for the next 20 years and was reaffirmed in the National Policy of Education (MHRD, 1986). Section IV of the National Policy of Education entitled “Education for Equality” states that “where feasible children with motor handicaps and other mild handicaps will be educated with others, while severely handicapped children will be provided for in special residential schools.”

Additionally, the Right to Persons with Disability Act (RPWD) Act, 2016, has expanded the scope of eligible conditions from 7 to 21, and now includes various cognitive disorders such as cerebral palsy, dwarfism, speech disabilities, autism spectrum disorders, chronic neurological disorders, etc. The propogation and normalization of learning disabilities has been further encouraged through the replacement of "mental retardation" with "intellectual disability" in major policy frameworks.

Designing smart policies requires a coherent and achievable strategy plan which are supported by a collection of deliverables such as monitoring mechanisms, timing, community engagement, etc. These multidimensional factors aid the effective implementation of the strategy. The feasibility of the policy is determined by the aforementioned set of factors in addition to the quality of institutions, economic trends, common public beliefs, etc. Therefore, a smart policy demands to put any logical plan into action by considering a nexus of the factors outlined in the figure, in order to provide context-based solutions to pressing issues, hence reiterating the insignificance of a "one-size-fits-all" methodology.

![Figure 4: Smart Policy Design](source: OECD)
AN EXCLUSIVE FOCUS ON SPECIAL NEEDS: WHY?

Research has shown that targeted interventions have optimal returns when implemented early on in a child’s learning trajectory. In general, cognitive stunting is negatively associated with academic performance of children, and stunted children perform more poorly in tasks related to memory and spatial cognition, thereby confirming that stunting is closely associated with poorer neuro-psychological challenges (Sanaou et. al., 2018).

Figure 5 shows that the rate of return on investment in targeted human capital interventions is the highest in the 0-3 age bracket and continuously declines as the student grows older, thereby reaffirming the importance of policies that improve cognitive abilities at an early age. Teachers hence play an invaluable role in ensuring that maximal benefits are imparted to students in every bracket. A reform in the quality and manner of teaching is imperative to help children realize the positive effects of early childhood education in the short and long run.

A traditionalist approach to teaching in India involves large classrooms with low student-teacher ratios and common curricula across all learning spectra. Hence, even if public funding exists, it is imperative for teacher training regulations to work in conjunction with the common goal of improving the quality of special needs education. There exists a lack of reforms to train teachers to employ innovative pedagogical tools that ensure responsive learning among students. The Right to Education Act and Persons with Disabilities Act are examples of interventions ensuring integration of these children into mainstream schools. However, a simultaneous institutionalized shift in teacher training methodologies has been missing, thereby leading to misclarity regarding the methods used to impart learning to such children. Consequently, teachers find it difficult to define inclusionary practices and thus implement them in their classrooms. Additionally, the lack of official training may disincentivize teachers from implementing innovative strategies in lieu of more traditional curricula. (Jangira, Singh and Yadav, 1994).
There have been some studies that have examined the paucity of teacher training mechanisms in India. Singh (2016) reports a study conducted in a school in Delhi, which found that approximately 70% of the teachers either had no prior experience in teaching disabled students or had never received the requisite training to teach children with special needs. This clearly exhibits the absence of skills needed by the instructors to cater to their students who require a distinct set of teaching methods and exclusive focus. Das, Kuyini and Desai (2013) conducted a survey of special needs training of 349 primary and 318 secondary school teachers in Delhi. They found that 68% of teachers did not receive any initial training in special education and 86% of teachers did not have access to any support services that could aid them in imparting alternate pedagogical tools. Given that the absence of a comprehensive teacher support mechanism is starkly evident in the Indian education system, it may impose a challenge to provide individualized learning paths to each student, thereby maximizing the likelihood that relevant content is taught after factoring in the extent and type of disability.

In schools that cater to students with special needs, the curricula tends to align with the “one-size-fits-all” approach, in which the same content and method of teaching are applied to every child, without taking into consideration individual differences, characteristics and needs (Polat, Adiguzel & Akgun, 2012). In order to move past this passive approach towards education, many learning centers have adopted technology such as computer assisted learning (Polat, Adiguzel & Akgun, 2012), although research suggests that either technology is not as widely implemented as there is a need (Lahm, 2003) or when implemented, is not customized and personalized enough (Somyurek, 2009).

These findings are especially distressing in a country as large and diverse as India. There exists a disparity in educational access in tribal, agrarian and remote areas, where practices like elitist and ghost teaching add to decreased learning outcomes (Chaudhury et. al, 2006). Additionally, the distribution of intrinsic motivation among teachers is skewed; studies have found that the probability of teacher absenteeism is much larger in classrooms with low-ability students (Duflo, Dupas and Kremer, 2011). Implementing large-scale teacher training programs is hence not a scalable option in the short run, especially in publicly funded schools situated in non-metro cities. While the long run impacts of effective training will have a proportionate impact on student outcomes, it is imperative to devise a solution to be used in tandem with teacher training to ensure that intellectual capital is honed in the short run as well. This is where human centered technologies can be used as a tool to improve learning outcomes.

**Fig. 6: India’s Education Market: A Brief Overview**

*Source: VCCircle Analysis*
One of the most effective technologies that have recently come to the forefront is adaptive learning. Adaptive learning technologies are pedagogical tools that provide individuals a customized learning environment to develop their skills in different areas in a continuous manner. Rather than relying on a one-size-fits-all methodology, this technology alters curricula based on the student’s learning curve. Much like an individual tutor, adaptive learning applications take cues from learning outcomes to adjust the syllabi accordingly. This ensures that the student understands every concept before progressing to the next. This heavily relies on artificially intelligent systems, since the program uses user-generated data to update its features and offerings based on a feedback loop. Figure 7 explains the main elements of adaptive learning.

**ELEMENTS OF ADAPTIVE LEARNING**

**ADAPTIVE CONTENT**
The application generates hints based on learning gaps and mistakes. The student answers based on previous feedback, knowing areas of concern.

**ADAPTIVE SEQUENCE**
The application operates on a feedback loop and analyzes real time student data to intelligently provide suitable learning material in the correct sequence.

**ADAPTIVE ASSESSMENT**
The application uses data on student responses as a benchmark to change the difficulty level of the questions. If a student is correct consistently, the probability of getting tougher questions is higher.

**ADAPTIVE PATHWAYS**
The application uses differentiated pathways to reach the same learning outcomes for children placed in various parts of the ability spectrum and follows different strategies for fast or slow learners.

*Figure 7: Key Elements of Adaptive Learning*

*Source: Generated by Authors*
Adaptive learning programs are increasingly being used by private and governmental organizations to impart knowledge in an efficient and cost-effective manner. The Abdul Latif Jameel Poverty Action Lab (J-PAL), in collaboration with Pratham Education Foundation, conducted a randomized controlled trial (RCT) in Gujarat, India wherein they provided Computer-Assisted Learning (CAL) curricula at school-level to around 100 schools. It was observed that there were significant differences between the treatment and control groups in the ability to solve basic Math problems over one and two-year periods (J-PAL, 2004). The Indian government recently collaborated with Central Square Foundation to adopt Personalized Assisted Learning (PAL) solutions in government schools. These studies have been launched as pilots, but concrete results have not been recorded.

In light of these recent developments in providing children with disabilities with more bespoke solutions for improving their educational experience, our team has developed Elevate: an intelligent adaptive learning tool for special needs children which offers a highly personalized virtual learning environment through analyzing real-time learning data and suggesting remedial lesson plans in the form of feedback loops. Through the Bayesian knowledge tracing algorithm, Elevate creates a customized learning path for students based on the nature, frequency and history of (in)accuracy, thereby facilitating an efficient learning mechanism.
THE SOLUTION: ELEVATE

STEP 1: COLLECTING STUDENT DATA

Elevate begins with an informational questionnaire which primarily gathers knowledge about the nature and extent of the learning disability, educational background and demographic characteristics of the child. Additionally, it collects data on student preferences, for example, the kind of activities that she/he would like to learn more. Such information provides a head-start to the application to adjust the initial difficulty level so that the student can engage with content that best targets their area of difficulty. Furthermore, to ensure effective scalability, it is important to control for gender, income and location related factors. For instance, providing the technology in rural areas, where the uptake of digital tools is still rudimentary, may make it difficult to implement the tech-enabled solution. Moreover, research also shows that girls with disabilities are discriminated to a greater extent than boys when the question is regarding the provision of education (UNICEF & WHO, nd). Elevate thus collects student data in order to recognize, track and ensure that these societal differences don't serve as impediments to equal learning opportunities.

STEP 2: GENERATING CUSTOMIZED CONTENT

Based on the previously collected data, Elevate conducts a pre-test covering key learning areas based on age, education level, student preferences and learning disability. There are essentially two categories of learning: content and level. Learning depends on “what” is being taught (content) and the “extent of difficulty” of the content (level).

Following a “if this, then that” (Bayesian Knowledge Tracing) algorithm, the application guides the learning experience of the student depending on their own trajectory of answering questions. For instance, if an individual chooses the correct answer to a question, they may be promoted to a higher level of difficulty. If they chose the wrong answer, the application will respond with feedback and additional questions.

Depending on the student’s performance, the application can perceive the following category of learning:
- what they already know and have now mastered
- what they lack competence in and what they need to know in the future.

Elevate thus dynamically processes real time user data to provide a highly personalized education experience to the child. This leads to the application essentially trying to understand the user's adaptability to the learning material and adjusting the material accordingly to facilitate a comfortable learning process for the student.
STEP 3: EVALUATION AND FEEDBACK MECHANISM

Along with its adaptive functionality, Elevate includes constant monitoring and provides students real time feedback on their progress, hence serving as a means of encouragement. Additionally, it generates data insights and recommends in-class activities to teachers by identifying points of difficulty. This feature serves multiple benefits. Firstly, teachers can provide additional assistance in key areas identified by Elevate. The importance of communication and collaboration between teachers and student is hence accounted for: the presence of a human may enhance the learning experience of the child and its interaction with Elevate. Secondly, live data insights partially solves the restraint created due to a paucity in data on special needs students in the Indian Census, thereby enabling future policy makers or organizations to take more data driven and informed decisions. To conclude, Elevate creates a feedback loop between teachers, students and technology, hence devising solutions that best cater to each child’s need and improves in class teacher efficiency. The prototype below describes the application workflow. *(Note that this is specifically for a phone, but the application can easily be made compatible with other devices.)*

ELEVATE: PROTOTYPE
Great! Can you solve the following math problems?

2+2+9  7+10  2x5 + 10  20+10+2

Good going! Can you spell the following words?

ale  bear

Great! Can you now drag the fish from point A to B?

Your virtual classroom is ready, Maya! Are you?
MAP YOUR LEARNING CURVE: BAYESIAN KNOWLEDGE TRACING

FIG 9: BAYESIAN KNOWLEDGE TRACING
SOURCE: GENERATED BY AUTHORS
IMPLEMENTATION

Until now, the focus of adaptive learning technologies lies in the domain of mainstream education. While research has shown the efficacy of this method of learning across ability spectra, there lies a gap in the impact adaptive learning can have on special education children. Given that the incidence of various cognitive disorders are mostly exogenous in nature, a direct causal link can be established through proper experimental design. Prior to any extensive implementation of Elevate, we believe it is necessary to confirm the impact of the application on a small scale.

In order to ascertain the causal effect of the application on different aspects of learning, we propose a randomized controlled trial (RCT) to be implemented in special education schools in New Delhi, India as a pilot study. The RCT methodology has been a pioneer in development economics research.

There are many benefits to using RCTs for this particular study: randomization will ensure that the only difference between treated and control groups is the treatment itself, thereby eliminating confounding factors such as age, sex, parental income, access to medical facilities/therapy etc, and will also ensure proper monitoring of students through an institutionalized structure, given that due measures are taken to ensure compliance and reduce attrition. Figure 10 provides an introduction to randomization.

![Figure 10: The Basics of RCTs](https://microbenotes.com/randomized-controlled-trial-rcts/)

Before discussing the implementation strategy, there are a few key considerations regarding the spatial distribution of special education centers in India. Due to the lack of awareness coupled with social stigma against mental illnesses, non-urban/semi-urban areas are less equipped to educate special needs children in an efficient manner, as compared to metropolitan cities like Delhi, Mumbai and Kolkata, which have better infrastructure and resources to support the learning of these children, as well as the presence of national and international think tanks to facilitate the process. Therefore, choosing special needs institutions in an urban metropolis for the pilot is a practical starting point. Once the results have been recorded, the application will be scaled at national level, involving multiple stakeholders to ensure efficiency and compliance. Some alternate scenarios have been described in later sections. The components of the RCT for a first-round review of the implications of introducing Elevate, are outlined below:
RANDOMIZATION LEVEL

To choose treatment and control groups, randomization will take place at the school level. A list of special education and inclusive schools in Delhi will be compiled and roughly 50% will be chosen for the first stage of the experiment in a random manner. Due to ethical concerns, each special needs student will be provided access to the application but at different points of time to facilitate comparison (randomized phase-in). There will be two sessions per week using the application through which the learner will complement regular special needs curricula with the adaptive learning environment.

TIME PERIOD OF STUDY

The study will take place over a 1 year period in every classroom in order to quantify the causal effect of using the application over an academic year. Due to ethical reasons, children cannot be denied an application that benefits them. Therefore, a randomized phase-in will take place wherein every subsequent classroom will be provided Elevate. For example: Classroom A gets Elevate in Year 1, Classroom B in Year 2 and Classroom C in Year 3. Then, we can see 1 year effect taking A as treatment and B as control. We can also see 2 year effects using A as treated and C as control.

TESTING

A pre and post-test will be taken over a period of one year through the app for each child. The diagnostic test conducted before prescribing adaptive curricula will be taken as a pre-test. The post-test will be conducted on the application in an adaptive manner, and will help ascertain the causal impact of Elevate.

Real life skill tests will be undertaken to ensure that the cognitive improvements from Elevate are directly transferable to soft skills such as spiral binding, candle making etc. (Note that special schools in India train students in soft skills, hence an improvement in these areas can be beneficial for the student.)

COMPLIANCE

A key issue in any randomized controlled trial is the problem of imperfect compliance. Children may drop out of the study. We believe that the strict attendance policies implemented by Indian schools in addition to smaller class sizes in special schools will help teachers monitor missing students.

STRATIFICATION

The sample will be stratified by disability: the treatment and control status will be assigned within each kind of special need. This is helpful in dealing with selection bias, since intellectual disabilities can render a differential impact on the pre-existing cognitive ability of the child. Therefore, if we don’t control for these differences, it may be possible that the treatment effect captures them.
The pilot location has been chosen keeping in mind accessibility concerns. However, to ensure large-scale implementation and a structural change in which special needs individuals are educated, hired and perceived by Indian society, this technology will have to be adapted to suit the local environment. The wide ranging diversity in the availability of resources as well as mindsets in India make for an interesting case in the application of this technology in different types of locations. The following table outlines potential disparities and possible adaptations of the application to suit the needs of the populace:

<table>
<thead>
<tr>
<th>IMPLEMENTATION AREA</th>
<th>POTENTIAL ISSUES</th>
<th>POSSIBLE ADAPTATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Areas</td>
<td>I1. Lack of internet and telephonic/communication devices to enable learners use this application/inability to use software.</td>
<td>A1. Identify districts with higher numbers of special needs children and provide village level funding to set up computer labs in major village schools which will facilitate the program in addition to training.</td>
</tr>
<tr>
<td></td>
<td>I2. Lack of social awareness on the importance of special needs education.</td>
<td>A2. Organize awareness camps in conjunction with self-help groups at a decentralized level in order to improve societal acceptance.</td>
</tr>
<tr>
<td>Semi-urban areas /small towns</td>
<td>I3. Lack of social awareness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I4. Lack of resources to ensure learning/lack of special education schools</td>
<td>A3. Local governments can organize awareness campaigns to build a positive product perception for the application, thereby encouraging schools to partake in the programme by offering the application to children.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A4. Local governments can be incentivized to allocate more resources towards these areas, in collaboration with grassroots organizations and teacher training institutes to provide personnel.</td>
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Table 2: Potential Disparities and Possible Adaptations
It is imperative to reiterate the importance of public funding, from an economic perspective, in any special education program aimed at targeting a large section of society, especially low income students. With respect to special education, the benefits per educated child (marginal revenue) show long run effects much later in life as compared to a mainstream child, but the cost of education is much higher until a larger number of children have been educated (since an increase in education leads to better infrastructure, resources and know-how which lowers economic and non economic cost).

The following figure depicts this situation. The marginal cost of educating an additional special needs child increases but at a decreasing rate. The marginal revenue increases after a certain number of children have been educated. Till point E, the net profit from educating an extra special needs is negative. Therefore, this gap needs to be filled through public funding which further incentivizes schools to invest in special needs curricula. At point E and beyond, schools break even and subsequently start making profits which is an added incentive, in addition to the public funding. After point E, there is a motivation for the private sector to invest and fund the creation of a special education infrastructure for children with special needs. This hinges on the free market hypothesis, which enables schools to proliferate when profits are high. However, an efficient form of public funding would keep schools in check when profits are low and ensure that special needs education is not being sidelined.

**FIG 11: THE ECONOMICS OF SPECIAL NEEDS.**
*Source: Designed by authors.*
ADAPTIVE LEARNING AND SOCIAL INCLUSION: ASSESSING THE BENEFITS

Children with special needs often face a damaging social attitude by their peers who are in the mainstream category. Given their lower academic performance than mainstream children (Das & Kattumuri, nd.), students with learning disabilities are often not accepted into social circles and bullied (Singh, 2011). This rejection by their peers may give rise to a feeling of loneliness (Pavri & Luftig, n.d), and potentially lead to mental distress including anxiety and depression (Cervone & Pervin, 2017).

Through the mechanism of adaptive learning, the learning gap between the child with a learning disability and his otherwise healthy peers is reduced, which may improve the self-perception of the challenged students (Cervone & Pervone, 2017). This may provide these children with the opportunity to achieve their ideal self (Cervone & Pervin, 2017), ie, appear similar to the “normal” children in some aspects (Das & Kattumuri, nd).

With the growing sense of belongingness through potentially intimate relationships, children with learning disabilities can attempt to move up Maslow’s Hierarchy of Needs (McLeod, 2020), and develop a much more consolidated feeling of accomplishment and eagerness to devise and achieve life goals. Subsequently, children with disabilities can learn how to function independently, engage in employment opportunities, earn an income and provide themselves with a self sustainable livelihood. As a result of the learning from Elevate, individuals who were earlier constrained by their personal disabilities, can now hope to live in better socio-economic conditions, thereby promoting the overall objective of social inclusion.

With any education policy, this adaptive learning environment will not only enable special needs children to gain as levelled a playing ground as possible, it will also have spillover effects on other economic agents. Below is a summary of some of these effects in detail.

**SPECIAL NEEDS CHILDREN**
- Increase in cognitive and motor abilities through personalized assistance to tackle knowledge gaps.
- Improvement of soft skills such as confidence and efficiency, thereby increasing job prospects and improving employability (depending on level of intellectual disability)
- Creation of role models for other schools/children to take inspiration from; especially relevant in India, with relatively low high level of social stigma attached to intellectual disability.

**PEER EFFECTS**
Improvement in cognitive abilities of special needs students will have a directly positive effect on mainstream students through improved interactions.

**WORKPLACE**
Interventions that promote cognitive advancement will enable firms to hire more efficient and engaged workers. At a later stage, firms can use this application to impart job-specific skills to special needs workers, which will further improve their efficiency.
TEACHERS

- A shift in the ability spectrum incentivizes teachers to challenge students.
- Availability of student specific learning data through the application helps teachers identify possible gaps that can be addressed in the classroom and hence increases teacher-efficiency.
- Frequent exposure to adaptive learning concepts may enable teachers to better understand student needs and use the technology in tandem with traditionalist teaching.

PARENTS

- Access to learning data will enable parents to plan suitable co-curricular activities for children at home.
- For children coming from poorer households, a steep learning curve will motivate them to invest more time in their child’s education with the incentive of long term development of social and human capital.

GOVERNMENT AUTHORITIES

- This intervention will enable government authorities to streamline funding towards special needs education in a realistic manner. Instead of relying on abstract teaching methods without imparting effective teacher training, the government can rely on data-driven insights.
- The gap between per-student cost and benefit that disdenticivizes schools from adopting special needs curricula can be funded in a relatively cost effective manner by the government.

STRUCTURAL SHIFTS IN OCCUPATION

Special needs individuals with higher cognitive abilities will most likely have better organisation and leadership skills. Therefore, with the help of government subsidies and investments, they can start their own independent enterprises thereby increasing representation and economic activity.
CHALLENGES AND MITIGATION

Firstly, as outlined above, teachers do not possess the training that is required to provide the special education that children with learning disabilities need. This ineptness may also be exhibited when the adaptive learning ecosystem requires teachers to intervene to either assist students with the technology or even elucidate a concept to the student. In order to ensure that adaptive learning is a complement to, rather than a substitute for human teaching, it is important for the government to spend monetary resources to train the teachers who are assigned to special needs students. By equipping the instructors with the technical and soft skills needed to interact with children who are relatively more challenging to teach than mainstream students, the communication gap is reduced and the psychologically comforting factor of "human touch" in teaching is restored. While this entails extra expenditure on behalf of the State, training teachers may create a favourable relationship between the teacher and student, that can consequently ease the process of learning for the children (Das & Kattumuri, nd.) and be conducive to achieving the ultimate goal of social inclusion.

In addition to ensuring that teachers are well aligned with the objective of the programme, it is also important to ascertain that the students are able to gain all the desired benefits of the programme. For instance, it is important to structure the content in an engaging and enriching manner, which encapsulates the children and eliminates attrition from schools or the pilot programme. Furthermore, it is imperative to determine the duration that students should leverage the adaptive learning tool, before switching to more mainstream instruction modes (if that is possible). While more mainstream education methods can be switched to when appropriate, the student should be allowed to use the application for as long as is required by them to reach a level of learning that is needed before making the transition. The idea is not to rush the learning process and ensure that learning is prioritized.

Furthermore, there may be logical concerns about the funding of the large-scale implementation of an adaptive learning infrastructure, if the pilot programme is deemed successful. In order to initiate a more extensive setup, the government can collaborate with education-technology (ed-tech) companies in India. For example, the government can induce the monetary investment needed by the startups to innovate and create the underlying technology. The government can then introduce the application into government run special needs schools, such as those for mentally challenged children, run by the Ministry of Social Justice and Empowerment (Thakur Hari Prasad Institute of Research and Rehabilitation for the Mentally Handicapped, n.d.). In this manner, the government is incentivized to incur an expenditure as they create a platform to improve the quality of education for students in their own centers. At the same time, ed-techs receive recognition upon partnering with the government, and hence may be motivated to make the application hardware and software. At a later stage, if this drive within public schools is successful, strategies can be developed to incentivize the private sector to enter into the market as well in the form of investors, application creators or even technology using schools.
CONCLUSION

As the world underwent a transition after COVID 19, educational institutions and workplaces turned towards technologies to streamline processes. However, a major segment of learners and future workers did not have a way to translate personalized learning through technology. To ensure social inclusion at a macro scale, policy making needs to be implemented using a "bottom-up" approach. If we reduce inequities in learning early on, the probability of individuals advancing in different walks of life are higher. The future is digital, and to ensure social inclusion, there is a pressing need to create bespoke solutions. Elevate aims to bridge the cognitive gap between special needs and mainstream children by recognizing the importance of personalized and self paced learning.

Recent data published by Indian authorities has a scant focus on special needs children. Additionally, our legal system has limited focus towards policy frameworks for special needs education. The broad commonalities that shape the lives of people with disabilities in India transcend intersectional divisions created by caste, gender or religion. We believe that systematic collaboration between grassroots/international organizations and governments can serve as a springboard for positive action with regard to special needs policy in India. Elevate will act as an aid to policy makers, organizations and schools to recognize and develop learning path for students from a personalized approach, thereby ensuring that no child is left behind.
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APPENDIX

A1. Stakeholder Ecosystem:

Partnerships and launching our path

The partnership section of this project is designed to collaboratively leverage existing capacities at multiple levels to better treat the children with special needs and ensure early intervention. Through creating an implementation mechanism with local education forces - street level bureaucrats, teachers - mobilize local expertise, regional collaboration can be promoted, hence ensuring a path to scale for government uptake of Elevate. The Partners identified for the pilot period can be classified into:

- Knowledge and Development Partners
- Technology Partners
- Funding Partners
- Governance Partners

Knowledge and Development Partners

Ministry of Social Justice and Empowerment, India

The Ministry of Social Justice & Empowerment runs targeted interventions for people with disabilities with respect to education and employment, suffering from conditions such as mental retardation, visual/hearing/speech disorders, etc. Collaborating with the government will lay the groundwork for the program uptake in the Indian context.

Ministry of Human Resource Development (MHRD), India

So far, neither MHRD nor Ministry of Social Justice and Empowerment have taken cognizance of the learning needs of children with special needs, and issued any directives for educational institutions to make virtual learning inclusive. Elevate will enable governments to leverage tech-based interventions for special needs children in public schools.

Niti Aayog (Policy Think Tank of the Government of India)

NITI Aayog has been at the forefront of recognizing the importance of artificial intelligence in policy making. The new plan of Niti Aayog proposes targets for elimination of gender disparities and inclusive education through artificial intelligence. This would ensure that the visually impaired are given more participation and allow for a more informative exchange. To support this the government under the Samagra Siksha Abhiyan has aimed at a project 2020 for inclusive education for children affected with autism, Parkinsons and learn through machine learning models.
Technology Partners

Data Security

We understand the importance of integrity, confidentiality and security. for this specific reason, administrative safeguards, will be set up to manage the accessibility of data collected and ensure the privacy of individuals involved in the process.

Privacy of the information collected is of utmost importance. Elevate's personal information and contact details would only be available to platform users granted administrative privileges, namely the project staff in charge of recruiting and on-boarding program participants. Additionally, organizations/governmental divisions requiring microdata for policy-making purposes will have to submit an application.

Outside of usage analytics, the software would not transmit or communicate any information back to the maintainers. The app information will be encrypted to avoid host servers from viewing the information sent and the data for visualisation would be aggregated to further guarantee the learners' privacy.

Funding Partners

The funding partners are earmarked for the short term, medium term and long term phases of the project:

**Short Term Funding** opportunities would support the start-up period of the project, including conducting needs assessment of the organization, app development, software licensing, hardware costs and early stage testing of the app in government schools. We have identified possible grants from the Indian Government department for this stage.

**Medium Term Funding** partners would allow us to attract government actors as scale up partners for this stage and facilitate the program in collaboration with the ministry of human resource development and the ministry of social justice and empowerment.

**Long Term Funding** will be secured through government initiatives in collaboration with the Corporate Social Responsibility division of the private players.

Governance Partners

**All India Council for Technical Education**

The aim of the organization is to study the aptitude of differently-abled students and assist them in getting appropriate employment when desired by them after their studies. This will in turn help us in collaborating with them as potential governance partners for the future of the project.

**The Hans Foundation**

In an era in which inclusive development has been emphasised it is important to take measures to focus on empowerment of children with special needs. The Hans foundation works very closely with them with their initiatives for Inclusive Education and ability based learning for children with disabilities and can help in conducting the pilot program in school.
A2. Distribution of Disabled Children in India, 2002

Generated by authors using data from Survey of Disabled People, 2002.

KEY: GREEN TO RED: MOST TO LEAST

*Note: The Survey of Disabled People, 2002 is the most recent survey undertaken by India exclusively for disabled people.