

Inclusion and Technology Design
Indian Institute of Technology, Madras

Lecture - 08

Designing an assistive technology eco-system for the visually impaired - The Vision Empower Journey

And what we are going to talk about is what we learnt in this process about creation of assistive technology. And why we learnt, why you know we need a technology eco systems, and what the technology eco system is all about is what we are going to share. So, it is a about designing an assistive technology eco system for the visually impaired.

And before we go to you know the technology eco system I know you all have had a large dose about disability, and you know there are experts also in this team here, right now. But a little bit of overview of words eye view on disability and the evolving nature of the concept of disability as we perceive it will be important for us, so that you know we can place vision empowers activities in that light.

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“Disability” – A taxonomy to label people 

- Disabilities classified into 9 broad single digit classifications (WHO 1970) :
Behavioural Disabilities (1) ; Communication Disabilities (2)
Personal Care Disabilities (3) ; Locomotor Disabilities (4)
Body Disposition Disabilities (5) ; Dexterity Disabilities (6)
Situational Disabilities (7) ; Particular Skill Disabilities (8)
Other Activity Restrictions (9).
- Each of these have several two digit subcategories such as Listening disabilities (23-24) as a subcategory of Communication Disabilities (2) or Ambulation Disabilities (40-45) as a subcategory of Locomotor Disabilities (4).
- Framework assisted in understanding the context of each disability and policies to address needs for special medical attention to each.

IITB-Dec11-2018 3



So, as most of you I mean know, and in the morning, I think Jerjith also discussed a lot about the medical models. So, when if you look at disability as a concept, right from 1970s the definition of disability was about a classification. It was about giving a taxonomy to the world, it is about classifying people with disabilities under various buckets and you know these there were 9 of these and then there was sub categories

under each one of those. So, eventually it was about creating a framework of understanding the context of each disability and the policies that were created was around each kind of disability. So, it was about classifying people who fell under each of these.

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“Disability” – Medical model to Social Welfare 

- *International Classification of Impairments, Disabilities and Handicaps* (ICIDH) definition of the World Health Organization (1980) identifies the sequence underlying disability as an illness-related phenomena .
Disease -> Impairment -> Disability -> Handicap
i.e. Policies to address disability focused on this **Medical/individual** model of Disability .
- Disability is not a product of bodily pathology, but of ***specific social and economic structures***. Disability is not a personal tragedy. Nothing is wrong with people with disabilities that needs to be fixed. On the contrary, what is needed is a change in society (Oliver, 1990, 1992, 1996).

HTB-Dec11-2018 4 

Now, by the 80s basically this model continued this individual medical model and you basically had a system where any disability was like handicapped in society, but was the root cause of which was a disease, a medical problem. So, the solutions which were created for those were also around the medical model always there was something to do with the individual medical model.

Slowly towards the end of that decade there were gradually critics of this model and people started talking about disability not being a product of a pathology, right. It was a specific, social and economic perspective that needed to change, right. And that became eventually talked about a lot people started writing about it.

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“Disability” – Restricting Participation



- Persons with Disabilities include those who have long-term physical, mental, intellectual or sensory impairment, ***which in interaction with various barriers may hinder*** their full and effective participation in society on an equal basis with others. (The United Nations Convention on the Rights of Persons with Disabilities - CRPD 2010)
- *“Disability need not be an obstacle to success. I have had motor neurone disease for practically all my adult life. Yet it has not prevented me from having a prominent career in astrophysics and a happy family life....But I realize that I am very lucky, in many ways. My success in theoretical physics has ensured that I am supported to live a worthwhile life. It is very clear that the majority of people with disabilities in the world have an extremely difficult time with everyday survival, let alone productive employment and personal fulfilment”* - Professor **Stephen W Hawking** (World report on Disability, WHO 2011) WHO, *World Report on Disability* (2011).

HTB-Dec11-2018

5



And this went on for quite some time, but it was only in the you know about may be the early 2000s is when the concept of disability the perspective changed a little further, where now you started the united nations came out with the CPRD and you know all of that.

And then you basically had the concept of mental and intellectual in sensory impairment being included within the you know frame work of disability, and it was about then participation of these people in society on an equal basis with others, and at that time disabilities became more than a social problem. It was it was something that required not just participation in terms of being physically present, but also in terms of mental participation.

Now, at the same time you will notice that along this time as this concept of disability the perspective of disability changed over decades, in parallel there was an another great change happening and that was to do with technologies. Technologies is also parallely were changing and if you know, if you around that time this was a famous quote from Stephen Hawking who said that disability need not be an obstacle to success because he was success full despite being so disabled. And what he said if you in this entire statement was he recognize that though he did he was able to succeed in what he was doing, he said majority of people with disabilities in the world have an extremely difficult time.

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“Disability” – A Development Issue



- Millions of persons with disabilities are denied an **education**, and for many more, education is available only in settings **where they are isolated from their peers** (Office of the UN High Commissioner for Human Rights [OHCHR](#) 2014)
- 1 billion+ people in the world disabled. 200 million are severely disabled. (WHO, 2016) i.e. **15%** of the world's population. Disability - not just a health problem or even a social welfare issue – it is a **human rights issue, it is a development issue**. Especially in **education**.
- **Accessible information and communication technologies (ICTs)** - a major policy objective in international normative frameworks concerning the advancement of PwDs and development (UN 2015).

HTB-Dec11-2018 6



So, it began to dawn on people by then that it would not be possible to solve the problem just by creating you know technologies or being able to address a particular section of people. And by 2014 is when you see that the United Nations comes out with the statement saying millions of people with disabilities are denied education, and many more education is available only when they are in isolated, in isolation.

So, this is when you start recognizing that there is a huge number of people who fall under the disability you know umbrella and you will learn about it in the morning about you know the different age groups spectrum, all that kinds of different kinds of disabilities. This section of the population is roughly 15 percent of the world's population now is considered to be disabled that is when people take notice of it and it does not remain as, even social you know forget of physical problem or a mental problem, not even a social welfare problem it becomes a human rights issue, it becomes a development issue.

Now, the governments needed to start ratifying whatever the United Nations was publishing or you know, each one needed to go back to their country and you know create bills pass bills and all that. And also along with that let I said for the assistive technologies were becoming one other policy objective by the United Nations. So, this is

going on a parallel. So, by 2015 you find them accessible and in ICTs became a major policy objective for the persons with disabilities.

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Inclusive Education and Assistive Technologies 

- **Inclusive education** is where students of all abilities learn together in the same classroom environment . This includes students with and without disabilities. It involves creating an education system where everyone can learn together and have their individual needs met. (UN 2014)
- The **Convention on the Rights of Persons with Disabilities (CRPD)** and its Optional Protocol (OP) were adopted on 13 December 2006, as the first comprehensive human rights treaty of the 21st century. It entered into force on 3 May 2008.
- **India** ratified the CRPD in the year 2007 and a new Rights of Persons with Disabilities Act (RPD) was passed in December, **2016**. Principles stated to be implemented included the "individual autonomy including the **freedom to make one's own choices**, and independence of persons".

UHTB-Dec11-2018 7



Now, once it became or you know development issue, one very important thing that what recognized as you show in the previous slide about the education you know being one of the most critical elements, right in development. So, this is where you come up with the United Nations come up with thus you know acknowledgement that inclusive education is required for all where all students can you know study together under the in the same classroom may be and how would was that going to be possible.

So, one is like we said all kinds of technologies accessible, assessable technologies, assistive technologies needed to get rolled out and all countries needed to ratify this. And this is what happened by 2007, India also ratified it. But if you notice despite all this it was only 2016 that India actually implemented the new rights of persons with disabilities.

And this is a very you know interesting statement in that bill, it say that it provides individual autonomy including the freedom to once won choices, right. So, this is what the legally every disabled person in this country is entitle to, the freedom to choose what they want to study, how they want to move around, where they want to leave, what job they want to do, these are all granted by the law, right.

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Visual Impairment in India


vidya empowerment
CENTRE

- 285 million people in the world who are visually impaired, 90% are in developing countries.
- While 39 million people are blind, 246 million have severe or moderate visual impairment.
- **One-third** of the world's blind population is in India.
- 0.77 million attend school.
- Compared to a national average of 26%, 45% of Indians with disabilities are illiterate.

Indian Census 2011

Category	Number of People	% of Total
Age 0-14	1044548	
Age 15+	3989083	
Age 5-19	1133472	22.52
School going in age 5-19	771288	68.05
Non-working adults	2008040	51.49



HTB-Dec11-2018 8

Now, we basically come to sense which come to you know the contexts which kind of presented to you how disability changed as a perspective and we come to India we basically realized that ok, this is a, this is the challenge. Vidya will tell you about what is the magnitude of the challenges as far as India is concerned.

Student: For in now 285 million people who are (Refer Time: 08:44) and this is in the world and 90 percent of them are in developing country. So, here when we refer to visually impaired, so it does not mean completely blind. This is visually impairment can change between different levels. So, if it is there are people who are completely blind, there are those who can see little they are legally blind and some of them cannot see very little, so there are different whole range of people among the visually blind.

And 39 million people in the world are completely blind and 246 millions have severe and moderate visual impairment, and out of this one-third of the worlds blind population are in India. So, here we should note that one-sixth of the population in the world and in India's out of which one-third, I mean out of like one-third of the blind population are in India, but one-sixth of the world's population are in India.

Why is it so because many people are just not aware of like eye sighted related issues, most of them are prevented in the cases of blindness? That is where 90 percent of the people in developing countries have visual impairment. And out of the Indian blind population there are just 0.77 million which is like 7.7 lakh people attend school. So,

there are 11 lakh children who are in the age group 5 to 19, but out of which only 68 percent attend school.

So, this is the status and when coming to STEM education. So, there are less than 100 people who are visually impairment who has studied STEM related courses in graduated, post-graduated level. So, this is just 11 lakh children are in this generation. Now, imagine how many generations have gone back. Out of all these generations just 100 students have taken STEM education, science technology as such courses in graduation and post-graduation level. So, this is the magnitude of the problem in India.

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The slide is titled "STEM for the VI person in 1898" and includes a logo for "Vedantu" in the top right corner. The main text on the slide reads: "Hellen Keller wrote: 'Algebra and geometry were the only studies that continued to defy my efforts to comprehend them...'" followed by two bullet points: "I still found more difficulty in mastering problems in mathematics than I did in any other of my studies." and "The administrative board of Radcliffe did not realize how difficult they were making my examinations, nor did they understand the peculiar difficulties I had to surmount." In the bottom right corner, there is a small video inset showing a woman with a headset, likely the speaker, in a virtual meeting environment.

Yeah. So, basically you know this to highlight the magnitude of STEM will that the or the problem of STEM education for the visually impaired this is what Hellen Keller told. Vidya, can you share that.

Student: Yeah. So, in so Hellen Keller wrote this. So, when she was she was there, she says Algebra and Geometry are the only courses which she founded difficult

And remember this is in 1898.

Student: So, Math was one of the toughest subject for her and because whole lot of issues were existing even there. She tells something about her college that college was not aware of how to get in to her needs and how they should teach her Math courses. So, this was long back when she was alive.

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USA, 2018, 120 years later



- Across the globe, persons with disabilities, especially the **visually impaired persons are widely using ICT products** in recent years for improving their personal and professional lives. (Neff, P et al 2009)
- “Today’s advances in access technology and technology in general enable blind children to progress in their learning as quickly as their sighted peers.”
 - - Denise Robinson (teaches visually impaired in Washington, USA)
[with technologies, such as Math-to-Speech Technology (Design Science), VPAlgebra (Henter Math), Tactile Graphics Display (NIST, USA), TTT: Talking Tactile Tablet (Touch Graphics)]

HTB-Dec11-2018 10



Yeah, and so about 120 years later now in her country ICTs are existing now in developed countries which can make there is enough research and not to show that ICTs do help in education of the visually impaired. It helps them to pick up science and math educational there are teachers who have who actually use those. You can see here these technology names are there which basically these are used. Now question is where are they being used and who is using them, and how is it affordable by everybody, right.

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India, 2018, 120 years later



- Even when a school has a functional computer lab with 23 computers, students are taught only MS Word and MS Excel; they are not used for teaching Maths, Science or other subjects. Miniscule of VI children take up Science and Maths
- In Karnataka, of the 45 schools for the blind, **one** school offers Science and Maths at a high-school level



So, now, just opposed to this to India 120 years later in India now, how is this.

Student: Yeah. So, let as you saw in previous slide that there are lot of technologies that they used in developed countries like US, but where in India we still have an issue. Like, when we go to one of the schools, so there are computers, it is not like there are no computers. Many people donate to computer, donate computers to blind schools because they feel that they can use it. But computers are functional, its the ratios not even like that not working.

They are working and there in good conditions, and people have computer classes at least have computer classes, but for what purpose they are being used it like when you go to school and ask them they just tell computer is equal to word and excel. So, just they type something on the keyboard and save it in word. So, these are the basic functionalities that that people have, people use in the computer right now in India. And they do not use it for any academic purposes.

So, in Karnataka we have 45 blind schools out of which there is only one school that is teaching math and science in 10th grade. This is the case in most of the states in India, so people drop out math, right from math and science, right from 5th grade or 7th grade because the government has given them alternate subjects like music, political sciences and so on because it is an assumption that (Refer Time: 14:07) cannot study science and math.

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Why should Technologists worry?


vedantu
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- Yet, specifically why do PwDs such as the blind, have to grapple with issues such as **inaccessibility, exclusion** and inability to participate fully in daily living?
 - Lack of sensitivity in design to their needs.. Due to..
 - Their exclusion from the technology design process.. In turn due to..
 - Very few technologists among the blind : For example, despite innovations in assistive technologies, PwDs such as visually impaired people are **under-represented in STEM** related areas even in developed countries such as the United States of America. (Center, 2018).

III TB-Dec11-2018

12



So, basically this is the finding that you know if there are 45 schools for the blind in Karnataka and there is only one school which is allowing science and math after class 7th. So, the problem really needs attention, right. So, now, why what is it that technology such are to do?

So, if you look at this entire problem. So, you know to grapple with issues of in accessibility and exclusion what is required now. If one thing we give out in the previous slide is that there are technologies and those technologies are not affordable. So, affordability is one issue, why we you do not have a enough technologies in the schools which can enable the children to study science and math, right.

But if you look at it what is it besides price that is coming in the way. The first thing that you would see is that during the design of these assistive technologies there is a lack of sensitivity in the design, right. There is a lack of sensitivity to the disabled community. When I am writing core or I am designing a hardware I the person who is designing it would not really think of that community as being the users of whatever you know we are designing.

So, this lack of design sensitivity, again is due to what, it is due to the exclusion of the visually impaired or any disabled person in the design process. So, when you are creating a assistive technologies you basically are not taking inputs from that community because there a minority and you think they are not users. Like what Jaljeeth said in the morning about visibility of you know this community. They are not visible. You do not see them as users. So, you do not consider and they themselves are not part of the design process.

Now, the question is if they are not part of the design process why are they not part of the design process. If you were today to expect that I as a visually impaired person should give you inputs. Today morning you saw the you know demo of jaws and you know there are other assistive technologies which help, but consider a situation where you design the technology to begin with which was accessible and you did not need an assistive technology like jaws, right. We did not think of that when we were designing the technology, right.

And why we did not think about it? And like if you want that you know visually impaired people or hearing impaired people or others join this community of designers then we would have to have them first of all educated in STEM studies. You would have

to have them go for higher education in stem. And how would they go for higher education in stem. First thing is they need to study science and math in school, right and then you can think of them going for higher studies in stem, in then we become designers, and then give inputs. So, it is like a whole wishes cycle which is the root cause of this problem. And this is this eventually leads to what everybody is trying about the under representation of these people in the STEM field, everywhere, in the developed countries as well.

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Vision Empower – Addressing the challenge

- **Vision Empower (VE)** is a not-for-profit enterprise incubated at IIT Bangalore.
- **Motivation:** Vidhya Y, a gold medalist in Masters in Digital Society programme at IITB is visually impaired since birth. She was the first blind student to take a Computer Science major in undergraduate studies in her university. Vision Empower was founded to realize her dream that no visually impaired child should be denied the opportunity to study Science and Mathematics, if they wish to.



Now, we come to what? Now you kind of have an idea of the broad scenario where vision empower was won. And the vision empowered, motivation of vision empowered is Vidya herself. She is a graduate of this institute, she was a gold medalist in the M.Sc digital society program of the 2017 batch and she is in inspiration in herself. She has had tremendous you know determination and great to fight the system and take up science and math.

And she took math in her bachelors, and then later she joined IITB for the masters in digital society which eventually talked, and after she graduated, she decided to work on projects to help the visually impaired study science and math. So, that was what we set out with.

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The VE mandate



- **Vision:** To empower the visually impaired through an inclusive education system.
- **Mission:** Vision Empower will make Science and Mathematics accessible to school-going children with visual impairment, at par with that of their sighted peers.
 - Identify the challenges discussed
 - Come up with ideas to deal with the problems just explained.
 - How to go about or even begin thinking of solving this challenge?
 - What are the initiatives that need to be taken and how to prioritize what has to be done?



So, we started this. And Vidya, can you say tell share what the vision and mission of visually empower was in your view.

Student: Yeah. So, we wanted to vision was to enable every visually impaired person to have an inclusive education. So, that they can teach them full potential. And mission was like because we wanted to teach math and science, but just like anybody else the quality of education should not be compromised, that is why we have to make it inclusive. And mission was to make science and math accessibility to visually impaired students because we already told you what was the problem.

So, now given that we understood broadly that ok, this is a vision that we want for the organization this is a mission we want to basically make science and math as STEM education accessible to this visually impaired students. But over all we had to come up with you know we did not know how what to do exactly. So, we came with the man deed we say would first need to go and identify the challenges, ok. One is Vidya herself had experienced certain had experiences, she there is also ted talks of hers on the net you can find look at here.

So, there was a bunch of experiences, but we really needed to go to the school so identify what were the day to day challenges that were faced by the children today. And then come up with you know ideas to deal with the problems that they were facing, and then

even go about thinking of solving this big challenge and then we have to come up with what are the initiatives we would take and how to prioritize those.

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Medium-term plan of activities

- **Year 1:** Research and analysis; Primary data collection; Requirements charter; Proof-of-concept prototypes; Identification of collaborators and other stakeholders; Create Phase wise Implementation plan ; Begin Pilot implementation for one grade in 1 school.
- **Year 2:** Complete pilot implementation for Maths and Science text books and IT based solutions for middle school; Start Implementation in at least 3 schools for the blind Bengaluru;
- **Years 3-5:** Content for all Science and Math requirements for junior school and middle school; Improvement of solutions; Implementation across all Karnataka blind schools; Scale-up and roll-out to include other schools and other school Boards and geographies



So, for this we came up with a plan and the first year this last one and half year we basically been on the research phase discovery phase. Maybe she can quickly say what we wanted to do in the research phase.

Student: So, what we use I had already, I had some insights because I gone through the system, but we did not want to conclude that this is the scenario right now because it was few years back. So, like 2011 and parts of the school. So, first what we did was we did some research, secondary research and primary research as well.

Secondary research to see if there are some reports we found some of them by HRCVC which is other organization in the mobile. So, they have done some research. Then we wanted to see if this scenario exists in schools in Karnataka. So, we have to do primary data collection. So, we went to schools, did some observations, sat with the teachers trainings and everything and we came up with some data, then we had to find out some requirements for our solutions, basically what to focus on in, what are what are the requirements that are there. And then we had some proof of concepts, prototype and then we cannot do this all by ourselves because so.

So, we will come to that speech shortly.

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Plan for the pilot project

Project Phase	Deliverables
Discovery	Research Findings and Analysis Documents; Concept note / White paper; Project scope document
Requirement	Detailed Requirements Document for Science and Math text books content; Partnership agreements
Solution Design	Design document for content of Science and Math kits for each grade; Sample prototypes for selected concepts; Design documents of ICT based solutions initiated by January 2018; Detailed implementation plan for pilot schools;
Proof of Concept; Pilot Implementations; Roll-out Planning	Working and tested solutions for selected requirements. Process Manuals for schools, NGOs, Assistive technology labs to document usage of kits, learning systems and accompanying processes. Teacher Training modules. Project Impact Assessment procedure. Policy Brief based on learning through the project



So, basically what was there was the first year we focused more on research, we used various research methods to understand and go with the pilot. Skip this.

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Discovery phase

- Research was aimed to inform the strategy to address the grand challenge of low number of VI students taking up STEM education or STEM related professions in India.
- ATs and policies for their adoption have rarely included the lived experiences of the visually impaired, especially in the developing countries (Pal et al., 2015). We used a mixed ethnographic approach of data gathering through participation and observation through constant interaction with various stakeholders and field immersion exercises such as observing classroom lectures, conducting institutional workshops and participating in teacher trainings as active participants in a peripheral membership role.
- Networking and knowledge creation through interactions with experts on pedagogy and educational technology, technology firms and resource providers working in this space.



So, basically the first year was the discovery phase, so try and understand you know and come up with the strategy, so that you know we would be able to enable the way as students with stem. So, you I will not go in to you know too much detail of what we did. We basically followed net pro graphic approach where it was mixed approach, we with certain observation in the class rooms in the teacher trainings in the you know various

engagements that the blind students would have in you know say labs and other places. And we also you know started networking with all the various players involved in this space, who are already working in this space.

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So, having done that, so there are few you know examples of as how we engaged with the schools in the you know community these are all some of the things we just to try to understand and what was being done.

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Discovery phase

Details of Interviews with Visually Impaired Participants			
VI Persons	Total participant count	Interviews Count	Remarks
School students	30	5 individual; 2 focus groups (15; 10)	3 face-to-face individual interviews at school; 2 telephonic interviews; 1 focus group of 15 high school students; 1 focus group of 10 middle school students; Participant observation of middle school students from August 2017 - March 2018 at 4 hours per week.
College University students	/ 26	2 telephonic interviews; 9 survey responses	15 at focus group interactions at Hackathon event Jan 18-19 2017 at IITB.
Working Professionals	9	5 face to face interviews; 2 telephonic interviews; 2 survey responses	5 interviews at IITB with VI programmers on Jan 18-19, 2017; Telephonic interviews
Teachers	2	2 face to face interviews; 1 focus group (6 of 12: VI)	2 interviews at school with Math and Computer teacher; 1 focus group of 12 teachers at Teacher Training (Nov 7 - Nov 11 2017) at an NGO
Technology Designers/Resource Providers	2	1 telephonic interview ; 1 face to face interview	Telephonic interview on July 25 2017; Face to Face interview on Nov 20 2017



So, we have us you know a kind of summary of all the people we interviewed, more than 100 people may be, various organizations, some working professionals, some sighted people who worked with them, right.

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Discovery phase

Details of interviews with participants who are not visually-impaired			
Non Visually Impaired persons	Total Participant Count	Interview Count	Remarks
Teachers	17	6 face to face interviews; 2 focus group (6;5) interviews	3 teachers at school; 3 teachers from coaching institute; Focus group at Teacher Training (6 teachers Nov 7 - Nov 11 2017) on Focus group at NCERT (5 teachers) on March 13-Mar 15 2017
Technology Designers/Resource Providers	5	5	5 face to face interviews on 5th April 2018, 12th March 2018, 13th March 2018, 6th Dec 2017, 20th April 2018



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Areas of concern



- **Accessible Science and Math content** - Lack of awareness and unavailability of Maths and Science content in an accessible format for the visually impaired
- **Instructors for the VI students and their capacities** - Lack of modes of dissemination and poor quality of mentoring (processes of teaching/pedagogy)
- **Infrastructure and technology aids** for the visually impaired, and the process of their creation and use - Lack of affordable technologies to assist the learning needs of VI students
- Lack of information and **perceived myths** about a blind and low-vision student's inability to pursue mathematics and science, among teacher schools and students themselves and their families. **Lack of role models** in the community



And after all of this we basically identified what were the main areas of concern, right. One is that you know you can just kind of go with the interview data and understand, but we tried and applied what we had learnt you are in the you know IT and society area where about doing qualitative research and we use those methods to basically come up and bucketize what was the main problems, right. So, if the main areas of concern what we found in the field could be you know summarizes these four.

The first was that you did not have accessible content. First thing, if we think of our children going to school or all of us who were sighted here who went to school the first thing that we think of about school is a what. What do you think of first when you go to school?

Student: Books, paper, pen.

Books, right, paper, pen, books, right without a book, we cannot even think of studying, right. Trust me, these children do not have books. They sit in class and they take notes on their, you know break pad, for whatever they are capable of. By the time they are they gains feed in Braille they are in high school and by then whatever they have learnt is pretty much by hearing in the class room. So, that is the first problem. You do not have accessible content.

Even if you had in there are people very well meaning people volunteers who come to school, they reads to books to them, right the or sometimes they give them recording also known is they give them some you know SD cards and stuff like that. But these children are not do not have do not have access to obey to re-enforce that learning. So, while you have some content in some where there is no way they go and do like we cannot even they do not do home work.

Are you about to do math without doing math home work? Never, right you need practice. All that just is does not happened because you do not have the content from which you are going to do the home work. You do not have the book how you are going to do that first thing.

So, that is the biggest thing. And that there was basically a lack of awareness you know. The fact it is been going on for decades but there are nobody in the school, nobody in the system seem to even miss a book. When we were going to the schools and asking, ok. So, how are you how did you do this?

Oh no, we did it. So, how do you do it in class? I sat through a test, I myself sat through a test and the at the end of the classroom sorry at the end of the period I walked out of the classroom and utter failure because I would never have been able to solve the problem the way the problem was been given to them and they were expected to solve it on their (Refer Time: 25:26) of frame, everything was order ok. So, this is the first problem.

The second problem was if today you are talking about these children you know you want them to study, you want them to you have content also, you have to be able to teach them, right. How many teachers in the; even in the regular schools that we have, right the school for the sighted, you will not get a teacher without a B.Ed degree. Every teacher has to have minimum B.Ed degree.

You go to their schools most of the teachers are class 10 or class 12 pass, ok. They do not have the qualification to teach, but they are teaching. Trust me they are very good teachers. They are well meaning, they very kind, they really want to help, they do a you know very good job. Given the constrains that they are in they go very good job. But they are not qualified, they are most of the 50 percent of them are blind. I am right, Vidya?

Student: Yeah.

50 percent of them are blind themselves. They have not learnt science and math in school. But because you do not have teachers who were up for the job these people are teaching. And the wherever we would go to the school, they would you know even now they basically come to us to ask tell us how we should teach, what should we tell, so that I can explain. I do not know how to explain. One teacher once told me I do not know how to explain, how a pyramid looks because it says it is like a mountain. I do not know how a mountain looks.

That is to the context itself is not there, how do you explain. Look at the books themselves, the content in the books, it will say it will talk of a parabola and said looks like an l shaped curve or u shaped curve, what is l, what is u. Have they ever seen? But context is not there. So, that there therefore, you know that the teaching community again is one group of people that we really needed to understand much better and try to have it, that is one.

The third thing like what we began with about you know the rolling out of technologies of the infrastructure required, tool it is required and other things required to teach this subject if you focus only science and math. Forget the other subjects, because we cannot be focusing on everything we focus on science and math. And if you look at science and math you need certain tools and gadgets to be able to make that you know convey the message and concept to them. There were hardly anything in the schools, even if there were they were not being used. So, that they are not there are there is an NIVH.

Student: So, it (Refer Time: 28:07). This is not a question there. When you said about teacher of the community not be able to be able to (Refer Time: 28:13). So, is there a proper content for teaching education itself especially for blind at least in there otherwise.

There is yes. So, and that is why I am just coming to right now. That NIVH exists, so national, right. So, NIVH has teacher training courses. There are all the metros have it, even some other cities have it. I will come to you, ok. They have it. But what they teach that is very generic it is a special education course and they will tell they will teach the teacher to you know do this.

When the teachers goes back to school, you know the teacher has no there is no way for you to understand whether the teacher is really using it in school or not, first. And you need to have you know it is not easy actually, honestly speaking it is not easy. So, these people when they go back to the school also very few actually get to using those tools and teaching them using them in the class room.

For example, you have a geometry kit which is about this big, right, about you know a foot long at least if not more, the geometry kit. Now, imagine every child using that kit for doing you know drawing for, not that this not possible it is possible. But the time it takes you cannot have a 45 minute period where you know you focus on which class has minimum of 12 children for the teacher to focus on each child, so that is where you know this the role of technology and infrastructure where you need much something what was happening in the box last few decades, right. Yeah.

Student: So, ma'am (Refer Time: 29:46) the diploma in the field.

Yes.

Student: There is one course, right.

Yes, special education B.Ed course is there.

Student: Yeah.

Yeah.

Student: So, is it different from a specially school and the government school or.

No, no its.

Student: (Refer Time: 30:00) for teaching.

So, in fact, you know what out of the 45 schools that in Karnataka that are for the specially for the blind, most are private schools only may be 5 or 6 are government schools the rest are all private schools.

Student: Ok.

So, the infrastructure and many of these are run by you know social organization, charitable trust and stuff like that. So, its it is there is the intension too, but you know putting everything to get the somehow is not happening and we will analyze why is not happening.

Student: Like, also special education when they doing that include all of other disabilities.

They do.

Student: Say that these.

Absolutely, right.

Student: They was then a certain type (Refer Time: 30:39).

So, they when they are teaching special education, they teach everything as you know as group because they do it for may be 2 years and they will teach everything. So, the focus first of all the focusing only visually impaired, and then focusing only on science and math. It does not happen. Many of the like I said many of the teachers who go there are them self visually impaired. So, you know for them to actually learn that and then because they never studied in school, then come back and teach. So, it is kind of the task is very huge. So, we will go little quickly [Laughter] otherwise I will not finish.

So, then you know the most important one is probably the last one, where there is a myth and we think that this person cannot see, so that person cannot think, right. It is our perspective that we imposed on that person. We do not know what they.

Honestly speaking I do not blame anybody because I think we all of us who have gone to you know regular schools which have not had a visually impaired person in the class or hearing impaired person in the class or a will not appreciate because it does not come in a day they are not visible, they are not, they are in the class room. So, we do not know, right the system itself has been like this and, so there is a myth its being percolating for years that you know they will this is not for them.

In fact, forget about that it was like you know even last year I was talking somebody from university of leads, he is doing a PhD in bio something pharma some kind of thing.

He was very interested in working with us, and he was on a call with me and we were talking to him about the hackathon, about you know other things and that leads to employability and stuff. And he was telling me why are you doing this, why do not you actually find out what they are good at and make those trades and then accordingly create employment.

So, you can understand where the perspective that comes. You know we are basically saying we are the ones to decide who was good at what, right, make those you know trades and allocate people to them like you saw in the morning you were showing the mess yours the you know. So, you basically identified was that person might be. You cannot see therefore, he can hear well, so he must be a musician. So, you know the let him learn singing. After that even if cannot do anything else at least he can go sit outside, right. So, that is what is being happening, right in this country forever [Laughter]. See that is the myth.

And then you know the biggest thing what we found is that because of this percolating thing which is cycle, there is big lack of role models. Like she was saying there were, but only 100 people may be in the whole country who studied science and math in higher education. And now you know it is known in education that you do something because you see somebody else as done in, and that does not exist and therefore. And let us.

(Refer Slide Time: 33:34)

Initiatives Required



- **Accessible Science and Math content** : Design modular solutions to teach and learn Mathematics and Science for visually impaired students at schools for the blind in Karnataka.
- **Instructors for the VI students and their capacities** : Create a pool of certified teachers trained to teach Science and Mathematics to visually impaired students.
- **Infrastructure and technology aids** : Design assistive technologies that will enable visually impaired children to study Science and Mathematics.
- **Perceived myths** : Highlight and engage with existing role models and ensure more awareness is built within the community



So, basically now to solve these problems what were the initiatives required. So, let us look at each of these buckets. So, for accessible science and math content we said we needed to design modular solutions. We basically needed to create the content, first thing. The content was non-existent we needed to create the content. Take the book, make the content accessible, so that the child will understand. So, whatever material is there make it write it in such a way, present it in such a way that the child understands that.

Second, you make it available to the child in the format that they understand, give them audio files, give them Braille books, you give them you know diagrams which are tactile whatever. You know trying to solve the problem through creating these kind of solutions give a child a kit, so that you know for every you know chapter they will have something to fall back on, right. So, that was the first thing, the second. That was the first initiative required.

The second thing was about the instructors, right. So, for the instructors you basically like we just not discuss, we need a pool of certified teachers. Now, certified quote unquote does not mean purely NIVH certified or you know special education certified for the job at hand, right and something we needed to design something for that.

Student: So, this (Refer Time: 34:52).

Yeah.

Student: Exquisite, how different is it teaching mathematics to a visual impaired student and a normal student or visually blind student?

So, considering this, you know you are trying to teach a child the area of a triangle, right. So, what you would do is you would draw a triangle, you will draw the perpendicular and then we will say this is how this is the formula you use and you will explain very visually, right. You need the board, you need to draw, you need to be able to explain it in terms of maybe even if you are really good teacher you will give examples from real world. You will give you will take applications take your you know something and say that you know or maybe touch something and see, you know you will put things together and explain.

The biggest problem that teachers in this schools have is they do not have a reference context, they do not know with what they can explain, so that the child will understand and because they are not being able to draw in the board and there is nothing else. So, usually what they will do is you will go with some strings or board or something or the Velcro at best and you know make tactile picture and try to explain. And how many people have the patience to do that? Right. So, that is why the challenge comes. But yes, there are.

Student: (Refer Time: 36:12) last point.

Student: You said the people faculty discouraged or and the people who pursue others stuff.

Yeah.

Student: They feel that would this be a projections of their own flue lessness.

Absolutely, that is absolutely what we feel that has been the case for ever, is that because we do not know to teach them we think that they cannot.

Student: And one more thing is like suppose you want to explain the human body, ok. So, if it is a cycle chain you might draw it (Refer Time: 36:42), So, the same diagram, so even make it accessible and show it to all visually blind student he or she would not be able to get.

Student: You need 3D stuff for all the complex to the diagram to need a 3D representation for them to understand. Like most solutions are designed the way sighted people can see and how they can grasp. So, when you look at it from a visually impaired persons point of view, the context in the way it is delivered and the way it is understood in detail everything changes especially in case diagram in a presentation.

Student: And higher ones.

Student: Higher one it is completely like for example, calculus and all of it. So, it is a very big problem, because they do not allow computers to your exams and then you have to do most of it orally. And you have lot of issues like scribes, those you write for you are in from lower grades, you know they have. I had experienced like one whole year I

struggled and at the end of the exam someone takes my hand and then they will just like draw some circle and one line and tell then look this is how this is there in the paper. I do not understand and go home and find out it is theta. So, it is just a complex problem. Firstly, you do not have books and you do not have scribes to write your results. So, it is like a (Refer Time: 38:07) your problems.

So, yeah, so it is you are absolutely right, that you know it is a perspective that you know we need to turn the [Laughter] mirror on ourselves and you know come back and see. So, we see instead of getting into, we will try to understand you know how to how we analyze this problem, right.

So, therefore, the need for the all this also to be able to do this you know we needed to create a school of teachers for the in infrastructure and technology, aids we needed to design assistive technologies and to you know to basically burst the myths we needed to you know engage with existing role models and kind of create more awareness you know beat the drum a little more, right.

Now obviously, you can see if this is the mandate that we are going to do solving you know addressing each one of these challenges itself is man worth, right. Each one in itself is a huge problem to solve.

(Refer Slide Time: 39:00)



Recognizing that Context is Key

- Requires a holistic and inclusive understanding of disability to open up avenues for improving existing solutions, both technologically as well as socially.
- We used the multi-disciplinary “biopsychosocial” framework developed by George Engel (1977).
- Attributes equal weightage to the three distilled views on disability:
 - **Biological:** implies the functional limitation caused by the impairment
 - **Psychological:** the personal or individual interpretation of one's own impairment
 - **Social:** refers to how impairment causes disability to the person when in a social setting or while interacting with various other environmental factors.



So, therefore, we decided that you know let us go in a slightly theoretical way, right. Try to understand, because people have researched it, people have researched this problems over the years, people have tried to address it. Nobody has done all of this on focus, whatever happened is not on purpose like. You cannot blame the whole of humanity for you know problems that arose to a group of people.

But the fact is it has arose because of certain changes in society. And that is why I know the first bit of disability and you know it is like repetitive and a gets boring, but it was very important for us to present that part because that evolution of the concept of and perspectives on disability, why it is changed, then when it changed is very important. And you will see how we tap on that to come up with a solutions.

So, basically if you look at it basically what we did is after all that you know going to the field, field work and you know collecting the data from all these various quarters we decided to go on a very theoretical thing, and try to understand who has said what about you know these kind of studies.

We found a very interesting frame work which is from the biopsychosocial framework developed by George Engel. This particular framework gives equal weightage to three aspects, biological, psychological and social. So, like what you saw that the concept of disability was changing from a medical model to a social model to eventually a humanitarian problem, right.

But if you look at how then to solve the problem also you need to understand all the perspectives. It not, it is not like where would you decide when you understood that it was a social problem the medical problem did not stop occurring it, it was still there, right. When you finally, decided it was a development issue the social issue did not stop, right it was still there. So, when you want to analyze the you know magnitude of the problem you need to understand that your solutions need to be tuned to you know be receptive to these you know signals, right. And therefore, we this we found is very effective and all are you know future work was kind of around this.

(Refer Slide Time: 41:24)

BPS enabled technology solutions



- The need for an “affordable” refreshable Braille display for every child
- In addition to Braille books, an accessible and affordable online platform for Science and Math content, especially catering to the needs of VI school students
- It is also essential that print content in Science and Math books be supplemented with durable 3D models and refreshable tactile diagrams with Braille or audio labels.
- The need for a standardized training curriculum for STEM teachers to be equipped to administer lessons to VI students cannot be overemphasized
- Technology enabled interactive learning tools and games assisted by a teacher to reinforce and enhance their learning



So, the you know biocycles a social enabled technology solutions what we felt was you know few of these which we found that we would probably need to work on. One was you know the first thing that I told you was the content, right the books did not exist, right. So, we needed something called a refreshable Braille display. Vidya, you want to talk about the Braille display?

Student: Yeah.

And why you need it?

Student: Yeah. So, refreshable Braille display is like a you the children who are needing the content of the users can read in Braille. But the content that is digital can be directly converted into Braille using actuators and the person who is reading can touch and feel it.

But, why do you need it?

Student: So, why do we, why do we need it is because now there are students who there are 12 students in our class for example, so each student should have one book. Now, the for example, you write one page of print that is equal to like three pages in Braille and these papers have to be special Braille papers which are thick. So, for one chapter you just need one entire book. So, one sighted text book what.

That is the magnitude of the problem.

Student: Yeah.

You basically have a book of 30, you know something of 30 pages which comes about more than 100 pages of Braille which is triple its size. And you have to print it using special equipment and then you have and the child can never carry it around, right, forget about the use. So, that is the reason also partly that you know it was not there, the books were not there. This is very difficult and then expensive affair to print. If there was one book in the class it would be with the teacher, that where the teacher is you know visually impaired otherwise you there would be no book.

Now, to solve that problem we found that this is the most important thing that we need to first create, a refreshable Braille display. Now, such devices exist there are such devices in the market you can go out abroad and buy somewhere between the range of 3000 to 5000 dollars each. So, can you give that to every child? No, right. So, that is that is why the quotation around your affordable. So, that is the first technology we started looking for and trying to put a team together to work. So, that is one. The second.

Student: 3000-5000 all (Refer Time: 43:42) actually.

No, no, no, no for a single display which has about.

Student: (Refer Time: 43:46).

20 cells, 20 to 40 cells each.

Student: That too refreshable.

Braille display.

Student: Display.

Yeah, I think if you are around some time, we can show you one which is yeah. So, now, there are Indian versions available, one or two companies have come up with refreshable Braille display of you know with the minimum price about 25 to 30000 rupees you are getting. But even that is not affordable like we told you, right. 90 percent of these people

come from rural and poor families that cannot afford. So, even 25-30 is very expensive for them 30 rupees and of the.

Student: Is the price high because of skill how is in this.

Yes, partly.

Student: Yes, because skill.

Partly, partly and also partly because it is very niche technology.

Student: This is the monopoly like that we going to.

It is not really monopoly. In fact, people we move, in fact, I know people who work on this and I write now we are also working what they are doing is basically is they are opening up the what they have, like you know the design is open design. So, I would not say its monopoly.

Student: It is not (Refer Time: 44:50).

At the same time yeah, there are the you know the say for example, now in this (Refer Time: 44:45) living countries it is highly subsidized because whatever is the price it does not matter, the government will buy it and give it to every blind person. So, they have one at hand always. But this does not it all countries cannot afford that. So, it is not possible.

Student: So, as a policy doing next to the craft see because of the volume after they have taken their limitations where the deputy government has (Refer Time: 45:15).

The role of the government certainly is there, but again you know we also getting go to that that stage where you know we are able to make a judgment on what was right and what was wrong. What we recognize is that this happened and, right now also we are even able to talk of refreshable Braille display because there are technology has developed till there, right.

If you if that had not happened then you know we would not even been talking about it, and trust me that would not have not happened if they you know economy was not open for people to innovate on. And obviously, people are innovating they will want to see the

terms of there, it all there it you know intellectual property. So, it is there is no right or wrong in it. Yes, but the government playing a role certainly from the policy side, from you know the involvement side, all that is certainly.

Student: (Refer Time: 46:02) options are that you to develop an affordable technology.

Yeah.

Student: That is not the thing. So, people has a (Refer Time: 46:11) challenges.

Yeah.

Student: The second option is that, ok, let us not focus on that, that is a solution, ok. Let us work on something which the varying you know classes can afford it, right instead of looking at a technology.

Student: Let us look at the support and you know make it affordable for the mass of the blind people.

Yes. So, making it affordable is a not it is not like if we are trying that, right [Laughter]. But it is let me assure you it is not an easy thing because you have to make the technology affordable means what it is the something that you are trying to achieve. There is one thing about design if you are trying to design you know smart phone you will want even, however, cheap the phone is you will want all the features of the iPhone in it. Yes or no.

Student: Yes.

Yes, that is what we desire. So, same way if we even if you are making an affordable technology you cannot compromise on the features, right. So, that is where the challenges come you know.

Student: Same way directly (Refer Time: 47:12).

Yeah.

Student: This term (Refer Time: 47:13).

Yeah.

Student: Eclectic car today cannot compete with the other cars.

Student: From a cost perspective.

Student: So, whatever R n D in due rate. So, in best nice car, so in a (Refer Time: 47:24) you get. Of course, that the they are not able to need to the crisis. So, what is happening is government is coming into pitch, center they are in inside the ways um. So, I feel that.

Certainly, government has a (Refer Time: 47:36) I agree with you.

Student: As I , probably you know that can be the thing.

What you all I do not know.

Student: (Refer Time: 47:41).

Now, whether you know just paying off for everyone is a solution or there are many ways the government has its not a. See the government I will not say you know has not been. That is today every company the has to get 2 percent of its funds for CSR, right. So, there is a way if not directly indirectly rather government is trying.

Student: So, through the direct indirectly you say

From whom.

Student: Very fresh equipment.

Student: Is there a direct subsidy?

By the government. No.

Student: I think gives that.

And not just that the government earlier importing Braille devices, Braille printer and all was you know duty free now they charge a huge sum of you import because they want you to make it here. Yeah.

Student: So, one more trialing is that there is no only Braille display that is required for STEM education.

Yeah, yeah.

There are whole lot of technologies now when you think of making everything that this subsidy model that is not going to work.

That is very true.

Student: because they are whole lot of technologies just by reading Braille you are not going to learn science and maths.

Student: Most of the topic, just to quickly reveal it.

Yeah

Student: So, in what does the government and you go away to the ministry of social justice and empowerment, you know we want more subsidies for sale specially Braille display, the secretary over there is taking with the so many more basic things for which the funds need to be allocated which is for higher unity agenda. So, often the priorities do not match and you know the fund always limited to this ministry. So, hence many times just even if they want they are not able to do it there is a scheme called ADIP scheme, where they do provide some financial support, but many times the quality of all the particles which procured is very substandard.

So, so that was the first thing. Then you know basically in addition you need to what we figured is like I told you the content itself was not there. So, we needed to ensure that the whatever the books contained, right they should be there on an online platform now that you have notes and you have everything else. So, it should be in an, but it should be accessible to the visually impaired child.

So, we decided to basically try and come up with an accessible online platform and which we will have the content and it will not just have the content it will also have the instruction kit. Like, you said does the teacher know how to teach, right they no they do not, the answer is they do not. So, then how do you solve this? So, try and first of all we will tell you how else we do, but in the animus, we are trying to come up with you know instruction kit which the teacher can follow and at least you know conduct the class.

Then, coming up with the training curriculum for teachers and then other games and tools. So, these were some then creating a laboratory. Laboratory is of you know one of the most inaccessible places for visual impaired people, right, so how to make it accessible.

(Refer Slide Time: 50:24)

Addressing the needs : BPS enabled solution

- For VI students to be inspired to pursue STEM education, it is essential to create accessible and affordable laboratory equipment in schools.
- Finally, our findings also indicate that accessibility needs of VI persons using technology products may be adequately addressed through active participation of these persons in technology design teams and eventually increase the adoption of these products.

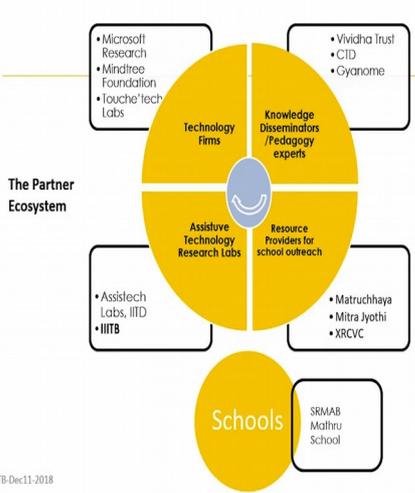
Note: However, the current under-representation of VI persons trained in STEM disciplines highlights the need to make STEM education accessible for them in the first place.





And then, you know how to be able to finally, be able to ensure that these people network with the entire STEM community, right. So, that is results. So, this is all about we needed to do.

(Refer Slide Time: 50:49)



IITB-Dec11-2018





So, what we using that biopsychosocial framework like I said we came out with a this is a unfortunate it is graphic (Refer Time: 51:00), that is basically I am just what we did is the whole we try to analyze. Now, I should you the more, problem set is huge. If you were to solve it and thinking the vision empower will go alone and solve of these problems, it will not happen in my lifetime I do not know how many lifetimes right. So, what we decided to do was work with the partner ecosystem where we can make it happen. There are many people in this place who are working on various things in their own areas and each one is working in some niche place.

So, when we looked at the ecosystem that exists today, we found that you can broadly group it into four large groups. One are the people who are the pedagogy experts, they create the books, they write the books, right. So, they are one group. There is another group who are the resource provider.

So, for example, in Bangalore there are 2 or 3 large resource providers who provide the Braille books on demand free of cost, ok. They provide it to the child. So, if the child actually goes to the that say Mathruchaya or the Mitrujyothi insist I need this books please give it to me they will give it you, print and give, right. So, that is the kind of plus other teacher trainings and all that they try to you know work on those thing.

Then there are the technology forms. Now, like a Microsoft that you know other firms who basically are creating assistive technologies to help with education. And then there are specific assistive technology labs now. Reason, many of the large engineering colleges and other science STEM related you know colleges you have assistive technology labs who are trying to work on state of the large assistive technology. So, broadly this is the supply side you know, they are trying to address the problems. And on the demand side of course, you have the schools you have the needs who raise the demands.

So, this is what we found it is and we decided that if we have to work then we have to collaborate with everybody and work, we have to ensure that everybody knows what the other is doing. Most of what we found is that there are lot many NGOs who are working in this phase then the resource providers like Mathruchaya, Mitrajyothi, XRC, VC these they have their resources. So, we try to work with them and you know creating the having the teacher training programs and so on and so forth.

For the technology forms we are trying to take partnerships wherein those technologies with which I said we will create. Now, we are just a 1 year, 1 year old organization. Creating a team huge team of technology experts is a dream, right. We have just 1 or 2 people right now. But what we are doing is we are collaborating with these other technology firms and trying to come up with a model and I will tell you how that goes on.

And then there are other technology labs. Now, IIITB, being in IIITB, this is another collaborative effort which is we are trying to kind of create where the basically it is like an academia industry partnership where basically we leverage on the knowledge of the experts here at IIT and the student pool that you have here to come up with technology solutions. So, that is how we work. And we have couple of schools who are our partners where we are trying out these solutions, pilot solutions.

(Refer Slide Time: 54:20)

Proof of Concept: Anubhav



Student: These schools are (Refer Time: 54:21) ma'am, oh.

Yes, right now kind of Bangalore because you we are eventually with that there is already like because of some of the things that we have done, there is already people are you know calling us asking us to go and try it in their schools you know. But we go do it probably later once we have a proof of concept which is you know verified.

So, yeah. So, for the you know content that we created the books the tactile diagrams and all of those we basically had this proof of concept program for learning off, where you know we brought the children, we try the material, we you know we some of the experiential learning you know concepts were tried with them and based on that then we proceeded with creating more material.

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Then we created the you know teacher training program. So, this was for, so the first one about content was tried out through this group of concept you know. The teacher training program called Pragya which we have where we basically we worked with the special education teachers. We split the whole you know curriculum for the whole year into 3 trimesters, and for every trimester we bring the teachers over and we run through the whole you know curriculum.

And it basically the special education teachers teach them how to go back and teach, because otherwise it is not be a scalable model. The current teacher needs to learn how to teach of course, you need to create more teacher, but the current teacher also needs to. So, we organize these every trimester. Another one is coming up in January.

(Refer Slide Time: 55:56)

Projects Initiated in collaboration with IIITB 

- Accessible LMS platform to act as a repository for all Science and Math content for school curriculum. (Mentor & Principal Investigator: Prof Amit Prakash)
- Design of an interface for automated creation of 3D printed tactile diagrams for text book diagrams. (Mentor & Principal Investigator : Prof T K Srikanth)
- Design of an audio labeling tool to reinforce the learning of diagrammatic representations in Science and Math. (Mentor & Principal Investigator : Prof Madhav Rao)



And then we have these technology projects which we have initiated along with IIIT, Bangalore. So, the first one like I told you the LMS which was created, so which is being created it is an accessible LMS which is to follow, and I am sure Ankit has you know trained you and now you understand the need for accessibility. So, we went with the particular platform which is opened and we try to make it accessible and then we are putting in the content in that. Then we basically like see here Vidya was talking about the 3D diagrams, right. You want to talk about the 3D diagram?

Student: Yes. So, for everything for most of the complex diagram. So, usually impaired during the learned class of the concept if there is a 2D representation. So, you need a 3D model for which someone cannot manually design was 2D model convert manually convert 2D model into 3D. So, they are trying to design a software with some added (Refer Time: 57:00) which can do that for some of the diagrams.

And also.

Student: 3D printer.

Using 3D printing.

Student: You are doing the software designed by IIIT.

Yeah.

Yeah, IIT. This is the model which we work as like this the collaborative model is that, there is a principle investigator in the institute and we have vision and power engineer and there are students, students intern and together we work on that. So, basically this particular one next you see is a algorithm is basically which was simplifying a diagram. So, in the book you have so many diagrams. So, you take any of the diagram and then you pass it through that algorithm it simplifies it and then you basically get an outline of that diagram in a particular way. There are it is sounds, it sounds much simpler than it is.

Student: (Refer Time: 57:46) gets (Refer Time: 57:47) about math, right.

Student: Maths.

Its math and science both.

Student: (Refer Time: 57:50).

So, we need diagrams for both.

Yeah.

So, for math actually good that you raise that question. In math if you see most of the diagrams in the math book in schools are very symmetrical and you know it is possible to even not use all this. So, what we did in the Braille book is we basically found a way to import it into the you know the file which is going to go to the Braille embosser and therefore, I can I should have brought some samples actually. So, and therefore, you can print that in a perforated way. So, you get raised diagrams. Symmetrical diagrams we were able to do that. So, we printed diagrams on the book using the Braille printer itself.

Student: And sorry graphs.

Graphs also. So, some of them. But like I told you we just find the thing, right.

Student: Yeah.

So, its class 5 material, but yeah, we have printed graphs. We had also printed graphs using this 3D tactile thing the. It is much simpler than you know biology diagrams. So, for that actually that is the other you. Can tell them about the they the (Refer Time: 58:53).

Student: Yeah. So, in science especially in biology in a when you take the diagrams that many label, some of them might have even 15 labels. So, having a Braille kind of labels it is very difficult because the children will get a (Refer Time: 59:09), what exact. Now, if you take a cell which is mitochondria which is cytochrome and which is like you through Braille is very voluminous it takes a normal space.

So, we are trying to create solution whether they will be a diagram. For example, a cell which is raised the student can touch and feel and when he or she touches a white colored part, so it needs how what a touching and give some minimal description of what the part is like mitochondria is the combo house with the cell something like that.

Audio label.

(Refer Slide Time: 59:47)

- Projects Initiated in collaboration with IIITB** 
- Design of an audio labeling tool to reinforce the learning of diagrammatic representations in Science and Math. (Mentor & Principal Investigator : Prof Madhav Rao)
 - Design of an affordable Refreshable Braille Display to accept files in any format and provide the equivalent tactile Braille output. VE is collaborating with a partner to contribute to enhancement of software and hardware, with support from IIITB. (Mentor & Principal Investigator : Prof Sujit Chakravarty)
 - Design of an input device for easy Braille input on a touch screen device. (Mentor: Prof Srinivasaraghavan)



Student: An audio label. When whenever he or she touches the frame parts it is it is audio labeling.

So, and so, these are the other than the other.

Student: Are the same (Refer Time: 59:56) at (Refer Time: 59:57) is being created.

Yeah.

Student: Did you find something (Refer Time: 60:01) of a market (Refer Time: 60:02)?

We use open endings, yeah. So, we basically there was a big process, initially we started we thought we will make our own accessible we took you know to, then we found it will be very expensive. Then we tried noodoe, noodoe also has many accessibility features we tried noodoe. But even that was not good enough.

And you know we have a we see one student in turn work for a whole semester doing that and then finally, we then used open it because it provides a its focus on accessibility is much more than any other. But we use that platform, but we have done a lot of customizations, and where, we will probably be you know putting back our code back to open it very soon.

Student: Just one thing about the LMS. It is like first, why we need to have separate LMS when there are many is because, firstly, the software should be completely accessible for a blind person and second thing we have lot of online math courses, but it is not like if its digital a blind person can read it. It is not like that. Because when you when you want to find any equation for example, on the internet the screen reader itself does not read it for you, it has to be converted into accessible formats such as read text and there should be a separate plug in which can convert all the equations towards and read it.

So, the content should be made accessible in a way that is the screen reader the interpret and then all the content should be supplemented with the Braille material. So, when you when it is given a problem there should be something some supplement in tactile format for the child to touch and see that and the software should play adjustable. So, all these three things go together we decided we have an (Refer Time: 61:43).

Student: So, this is the thing in math (Refer Time: 61:45).

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Yes, yes. This is the things we have to construct and like that is why you know, so, if you real the initially I began with the biopsychosocial framework, right. So, all the technologies we said should imbibe some of that. Should, imbibe the fact that it is not solving only a biological problem or only a social problem or only a psychological problem. Many assistive technologies are just created and shelved under the carpet because they are never used, right Ankit.

Student: Yes, absolutely.

Then are.

Student: Most of them are.

Yeah.

Student: Chlorofying the labs (Refer Time: 62:20).

It is exactly, they just stay there, ok. Nobody uses them. Then why, I mean ideally you would think oh there are technologies and then why are these people not using it, right. They are so unintuitive that you know people do not use it, and the trust me, I needed this is the research we basically went and spoke to the people who make a it and when we asked them how did you create it. So, they did not even talk to the user before they make it. They go with their own you know interpretation of what they want, what the

technology should be like, they create it and then they go and say try it should work why are you not using it.

What we are basically adding to is exactly what I was trying to say. Is that if when we create a device and we have to creating a technology because we know this technology will work as far as we have designed it, so it should work. But who is going to use that device and what are the parameters that that person is going to apply when or attribute that person is going to think about when using that device. You know how many questions come up about you know the that I know it is a basically what you are addressing is a biological problem, right.

Student: Yeah yeah.

Now, where is the psychological part coming in. Am I thinking about whether the person is ready for it or not? Does he want to be seen using that that particular thing or not? Right. There are so much stigma that is attached may be to that and they do not want to be seen using it.

There are so many various depends also from which data of the you know society you come and what how you want to be perceived by others. There are so many aspects to it, it is not like we can say that create it and of course, there is no one single hand solution also, but at least when you create a technology if you consider all these perspectives then you uptake might be better than what it is. Yeah.

(Refer Slide Time: 64:08)



The Inclusive Stem Hackathon is a unique, 24-hour hackathon where blind and visually impaired developers come together with sighted industry professionals and CS students to work on exciting and challenging problems.

And then, so, putting all that together now the question about you know what I told you about what we decided to do regarding the perspectives, the myths that are floating around you know how to create more awareness, right.

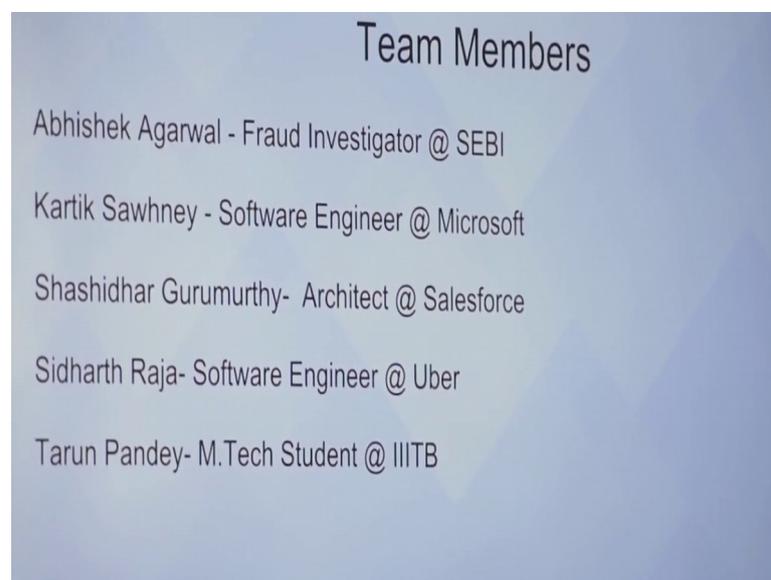
So, one of the groups which we collaborated is an I STEM it is an inclusive STEM group. Like, she was saying there are about maximum 100 people who are in STEM education, higher education, there are about 25 to 30 people who are in higher education right now and they have created a cell fabricacy team, we partnered with them, and for the first time last year here in IIIT we had the inclusive hackathon.

So, we basically had you know 12 groups of 5 members each where we brought brought people from the industry, we had the visually impaired programmers and we had students from IIIT. So, you had 2 visual impaired programmers, 2 people from industry and 1 IIIT student working on a problem, over 3 days we had the hackathon. And I will just play this little.

Hi, my name is Kartik and I am a co-founder at ISTEM. The goal of the I STEM hackathon was essentially to bring together blind computer science students or for professionals and sighted computer science students together to hack on projects of their passion about. And going into the event we had three broad objectives.

The first objective was for all of these (Refer Time: 66:00) to charge themselves by working in highly diverse teams. We were sure that they would actually be experiencing a lot that they have not experienced before. A lot many perspectives that they have not considered before, and really you know challenged and questions some of the frequency of notions and biopsies that they may have about each other. So, we have wanted them to break these biases to overcome these biases and really try and understand each others abilities, each others challenges, strengths, weaknesses, and learn from the overall experience.

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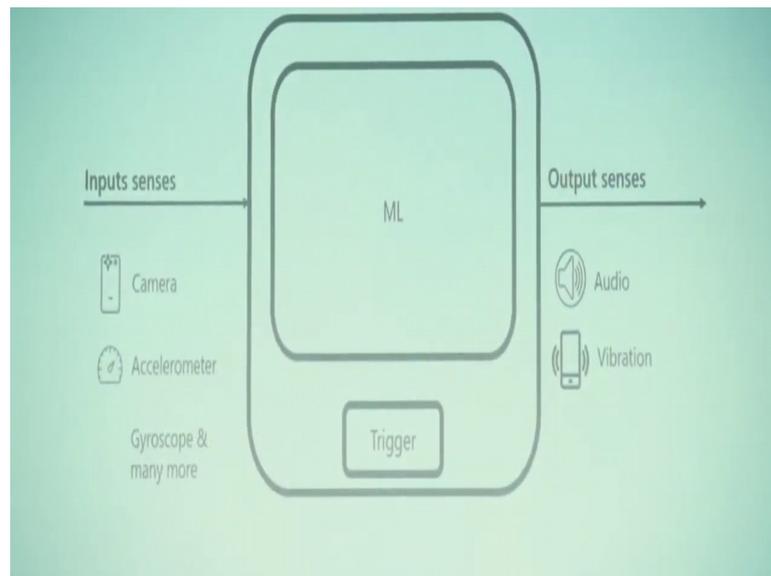


The second objective was for them to really understand what diversity leads to. Diversity leads to better products, because you are now considering perspectives and or ideas you never thought about. You are not thinking about problems that you never thought were problems. So, we wanted them to appreciate the beauty of diversity and how that leads to better products and better product development lifecycles.

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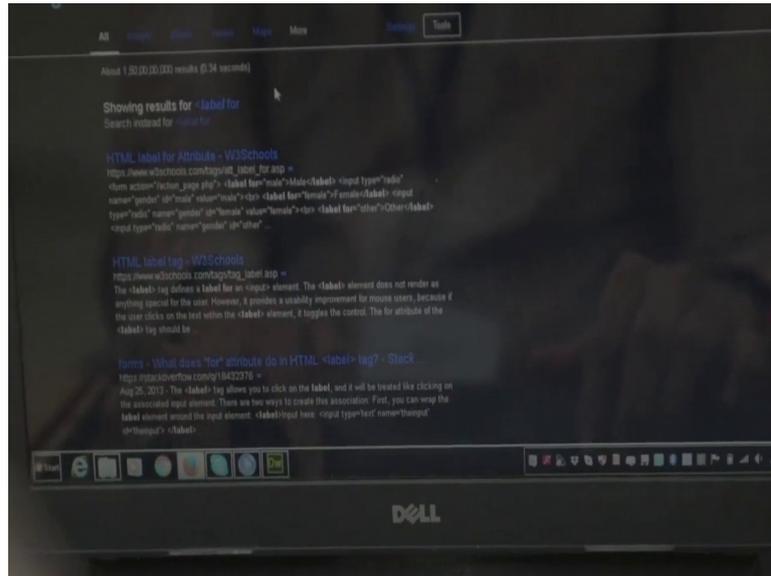


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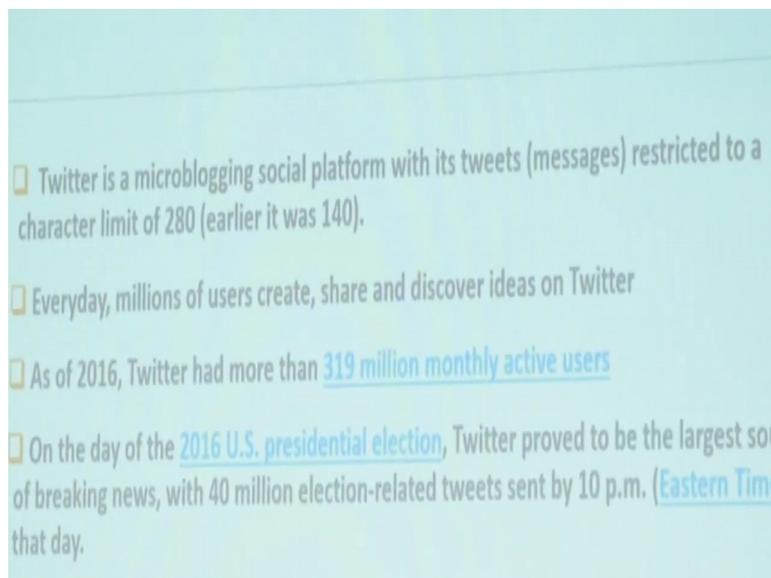
As finally, the third objective was for participants especially excited participants to try and understand accessibility hands on and bring it back to their organizations. It is one thing to take an accessibility course or accessibility brand by, but it is completely different thing to actually see that in action. Because now the product that you are developing will be unusable by our own teammates if it is not accessible.

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So, we wanted them to see how those changes those 2 or 3 lines of thought they were writing to enhance the accessibility of their apps, they transform it had that would have in helping that product, now being usable by their own teammates.

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So, we wanted them to really take this knowledge with them and understanding with them, so they can now be the champions for a accessibility at the respective organizations.

At vision aid one of the programs we run is to train visually impaired students, skills in the programming languages. So, students stay with us for 1 or 2 semesters you know, each semester lasting about 3 and a half to 4 months to learn programming and we find that once you learn programming going to these hackathons it is an excellent progression for them.

So, as these hackathons, they are able to connect through pairs, they are able to connect with they perform the industry with a students on college campuses and they are able to build exciting projects and actually understand what it is to apply academic skills into building practical solutions and in some cases also getting connected with employment opportunities. So, these hackathons are been real answer to vision aid and a bone to our students.

The inclusive STEM hackathon provides corporate with the unique opportunity to witness the vibrant space which is ideal for the development of inclusive technologies. Secondly, it allows for great sum opportunity to recognize the talent and capabilities of these passionate individuals who are so determined to overcome their challenges and focus on their strengths instead.

And thirdly, it allows the cooperates to observe the learnings from the hackathon, go back to their workplaces and implement the accommodations that are required, so that they may be able to employ talented individuals and provide them with an opportunity to bloom to their full potential.

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(Refer Slide Time: 69:58)



Now, so that was one networking. The other is the Ananda volunteer program that we started. So, it is basically see when we study we go back home and we have somebody to tell us to go back do our home work, somebody to follow up with us on you know whether we understood something or not, right, encourage us when we do well, scold us when we do not do well, right.

All these things are there, part and past of growing up. Most of the schools for the blind are residential children stay in school, there is a very happy lot no doubt, but they do not

get that reinforcement. So, we started this program where we go over weekends with the volunteers sit down with the children with their books and we have given each child a book now a this. So, we take the book the you know, volunteer comes with a printed books and we go through the material that was done in class over the week and reinforce what was done in class. So, this is a big hit among the children and they love their guides.

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And couple of recognitions here which Vidya has brought to vision empowered. She won the Namma Bengaluru Award. So, and so won the TIE, Delhi NCR award and I think 2 or 3 more others awards which I do not have right now.