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Baseline Report

Saurabh Prasad

saurabh19101@iiitd.ac.in
New Delhi

Imparting STEM based Education for Visually Impaired

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1. Executive Summary

Traditionally, visually-impaired (VI) students have faced limitations in pursuing higher-level Mathematics and Science courses, with many special and mainstream schools providing an option to discontinue these subjects after the 8th or 10th grade. Studies indicate that a significant 70-80% of VI students avoid Maths in higher education, thereby diminishing their presence in STEM fields and limiting job opportunities. This perpetuates the misconception that VI students cannot effectively engage with STEM subjects due to perceived cognitive impairments. However, recent technological advancements have debunked these notions, showcasing successful instances of VI individuals thriving in STEM careers.

Our research seeks to elucidate the factors constraining the participation of blind and partially-sighted learners in Mathematics and Science education. The focus extends to analyzing student interest, the role of educators, parental and pedagogical expectations, and avenues for mitigating these limitations. The study also incorporates the perspectives of students who opted out of Mathematics early in their educational journeys and examines the subsequent impact on their lives.

To gather comprehensive perspectives, we devised a robust questionnaire and interview structure. We engaged approximately 100 VI students and 15 associated teachers across 15 schools in Delhi. The student cohort ranged from 6th to 12th grade, divided into three sub-groups: students in Classes 6-8, those in 9th grade and above pursuing Maths, and those in 9th grade and above without a focus on Maths. Students utilized a shared Google-Form questionnaire, while teachers participated in individual interviews.

Our findings reveal that, in addition to challenges related to inaccessible study materials and student reluctance, other significant barriers include financial constraints, societal expectations, awareness gaps in local schools, and geographical considerations. These factors collectively impede the participation of VI students in higher education, particularly in STEM disciplines. The paper concludes by proposing crucial measures to address these challenges and create an inclusive environment, fostering the advancement of VI individuals in STEM education.

2. Background

2.1 The growing significance of STEM in the lives of persons with disabilities

STEM education is a transformative force shaping societal paradigms by cultivating a fresh mindset and imparting universally valuable skills applicable across professions. It establishes a crucial nexus between school education, future professional endeavors, community sensitivity and global perspectives. In the post-pandemic era, characterized by a pervasive shift to online mediums in education, healthcare, employment and various services, the indispensability of technology is accentuated. For individuals with disabilities, technology assumes an even more pivotal role in enhancing accessibility and establishing a barrier-free environment.

2.2 Exclusion of students with visual challenges from an accessible STEM education

The inception and progression of innovative thinking trace back to the initial classroom experience. Regrettably, numerous students, specifically those with visual challenges (VI as per RPWD Act 2016), encounter limitations in fully leveraging educational resources. Our evidence-based observations focus on this cohort.

2.3 Vision and its relevance in studying STEM-based subjects

Vision stands as a vital facilitator, enabling unobstructed access to information crucial for students' development of mathematical concepts and procedures. Its absence complicates the comprehension of spatial and directional concepts, thereby limiting opportunities for students with visual impairments in STEM fields [3].

2.4 Understanding Visual Impairment

Visual impairment, whether congenital or acquired at any life stage, is categorised into B1, B2, or B3. B1 signifies complete eyesight loss, while B3 refers to those with 50% or more eyesight.

2.5 Primary access barriers and their causes

Variations in eyesight, cognitive function and personal interest among students significantly influence the development of mathematical thinking and related STEM skills.

2.5.1 Inaccessibility of Mathematics and Science textbooks

Mathematics and Science textbooks, predominantly visual, contain numerous images, graphs, charts, diagrams, figures and drawings to elucidate complex concepts. Unfortunately, the absence of Braille or digital descriptions renders these materials inaccessible for blind and partially-sighted students. Accessing technical notations, such as equations and formulae, in accessible formats becomes challenging.

2.5.2 Limitations with available tactile graphics

Discrepancies between tactile graphics and their print versions contribute to the misinterpretation of presented information, hindering effective learning.

2.5.3 Challenges in performing experiments in Science labs

Engaging in activities such as chemical experiments in the lab poses another challenge. Usually, students with blindness do not complete their experiments independently. Instead, they are teamed with a group of sighted partners where they elaborate on all the steps of the procedure and take down notes about what is happening. This indeed opens their understanding of the experiment's purpose but it does not teach them how exactly to execute the experiment.

2.5.4 Role of teachers and limited expectations from students with visual challenges

Teaching STEM subjects predominantly relies on traditional 'chalk and talk' methods, placing an additional burden on teachers to articulate visual concepts in words when it comes to teaching students with blindness. Parents and teachers tend to have comparatively lower expectations from students with disability and thus students do not receive enough encouragement and motivation to try out different methods. [1]

2.5.5 Primary reliance on special schools and isolation from regular schools

Traditional classroom practices act as significant barriers, impeding the performance of visually impaired students in STEM subjects and segregating them from mainstream education. A notable study indicates that approximately 70% of students with visual challenges discontinue Maths and Science subjects in higher education, with only a few opting for technology-related careers [2].

2.6 Consequences of access barriers

These access barriers create an education gap between visually challenged students and their sighted peers. Due to these barriers, students are likely to have a negative attitude regarding their possibility to succeed in STEM fields. False assumptions get the boost like blind students cannot pursue STEM subjects and related jobs. Some even believe that visually impaired students have cognitive impairments that inhibit them from learning difficult concepts [4]. There are significantly smaller numbers of visually impaired people who complete their Ph.D. in STEM disciplines or those who are independently working in STEM-based jobs [5]. Their under-representation in the development team causes the accessibility improvement to remain ambiguous on the products such as apps or software used in day-to-day life. Despite these challenges, a proper accommodation and support system can facilitate overcoming access barriers for students. Through our study, we aim to explore such possibilities, as outlined in the objectives below.

3. Objectives of the Study

1. Comprehending STEM Challenges:

Analyze specific challenges faced by visually impaired students in studying Mathematics and Science within the STEM framework.

2. Assessing Learning Methods and Materials

Investigate preferred learning methods, including comfort with Braille or technical approaches, and assess the accessibility of learning materials such as textbooks, geometry kits, and tactile boards.

3. Teacher Dynamics and Classroom Inclusivity

Examine the role of teachers in classroom dynamics, including the coverage of topics and the necessity for additional support. Explore measures taken by teachers to fully include visually impaired students, especially in science experiments.

4. Examining Independence and Scribe Assistance

Evaluate the independence of visually impaired students in following textbooks and performing experiments. Assess the compatibility with scribe assistance during exams and identify any associated challenges.

5. Understanding Perspectives and Aspirations

Gather views from both students and teachers on challenges, enjoyable topics, and potential solutions. Explore aspirations of visually impaired students regarding STEM-based careers.

6. Adapting to Pandemic Changes

Investigate the impact of the pandemic on classes, focusing on the continuity of education and how the shift to online learning has affected the learning experiences of visually impaired students.

7. Highlighting Career Opportunities

Provide insights into the career opportunities available in STEM disciplines for visually impaired students, emphasizing potential paths for their professional development.

These overarching objectives encompass the multifaceted aspects of the study, ensuring a comprehensive exploration of challenges, resources, perspectives, learning dynamics, teacher roles, and the impact of external factors on visually impaired students pursuing STEM education.

4. Participants, Methods and Procedures

4.1 Participants

For our study, we broadly targeted two participant groups:

1. About 100 students with VI ranging from Class 6 to Class 12
2. 15-20 teachers/volunteers involved in teaching Maths and Science subjects to these students

Following this, to again break down the analysis into specific situations, we divide the students into 3 sub-groups:

I. Students in Classes 6-8
II. Students in Classes 9-12 with Maths
III. Students in Class 9-12 without Maths

Each sub-group had at least 30 students.

4.2 Methods

4.2.1 Recruiting students for the survey

We carefully underlined all our objectives and prepared a comprehensive questionnaire for every student group. Questionnaires had enquiries about a wide range of issues faced by students while studying Maths and Science subjects. Survey questionnaire

We contacted about 15 special schools and organizations based in Delhi and outside Delhi and requested them to circulate the survey form to their students. Students were informed about the purpose of our study and they provided their consent to participate in it.

We collected the responses from a total of 98 students, of which 34 were from Classes 6-8, 32 were from Classes 9-12 with Maths, and 32 were from Classes 9-12 without Maths. Our sample comprised of 68 male students and 30 female students. 62 of them were from special schools while 36 belonged to regular schools. Students were asked if they had infantile or late blindness to which 75 of them reported to have infantile blindness while 23 of them marked to acquire it later in their life. Besides, in our sample, there were 29 students with partial eyesight and 71 with complete blindness.

4.2.2 Recruiting teachers for a talk

The purpose behind having an unstructured discussion with teachers was to gain an idea about the existing challenges in accessing Maths and Science subjects in different special schools. It was important to understand how each of them tackled the difficulties through their own invented practices. We also wanted to note down their suggestions on how we could escalate

the participation of visually challenged students with STEM subjects in higher classes (9th and above).

4.3 Procedures

Students completed a Google-Form-based survey which took about 15 to 25 minutes. The overall survey had questions regarding participants' demographics, their interest in Maths and Science subjects, topic-wise convenience and challenges, their dependence upon Braille and technical devices, textbook accessibility, familiarity with useful assistive devices, experiences during offline to online shift of classes and their career goals.

Students with Maths were asked to rate each of the topics such as Arithmetic, Algebra, Geometry and data handling on a scale of 1 to 5 based on their convenience or difficulty in studying. They were asked about their preferred tool for performing calculations i.e. Braille equipment or digital devices. They were also debriefed on the issues they faced while accessing the Maths and Science textbooks available to them. Then they were asked if they had access to assistive tools such as geometry kits and tactile diagrams. They reported their contribution during lab experiments. They were asked about the improvement or deterioration in their performance after the offline to online shift of classes. They commented on the medium of instruction and how sometimes regional languages limit their scope to access even the accessible available resources. Next, they testified about the support and accommodation they received from their teachers. Thereafter, they were questioned if they wrote their exams with the help of a scribe or through a laptop/computer. They elaborated on the drawbacks experienced while writing exams with a scribe. Lastly, they were asked if they were willing to pursue STEM as a field for their career.

5. Survey Results

5.1 Subject preferences (Group 1)

Which of the following subjects do you enjoy the most?

Group	Group I (Classes 6-8)	Group II (Classes 9-12 with Maths)
Number of responses	34	32
Maths	14	8
Science	16	15
Social Studies	4	9

5.2 Mathematics

Which of the following topics in Maths do you find comparatively difficult?

Group	Group I (Classes 6-8)	Group II (Class 9-12 with Maths)
Number of responses	34	32
Arithmetic	4	1
Geometry	19	25
Algebra	8	5
Probability/Statistics	3	1

Which of the following tools do you use for studying Maths and doing calculations?

Group	Group I (Classes 6-8)	Group II (Classes 9-12 with Maths)
Number of responses	34	32
I use Braille script.	19	7
I use technical devices (laptop/computer).	4	10
I use both Braille and technical devices interchangeably at my convenience.	11	15

Which of the following tools according to you is more handy and helpful for studying Maths?

Group	Group I (Classes 6-8)	Group II (Classes 9-12 with Maths)
Number of responses	34	32
Braille	23	13
Technical devices	11	19

Is the Maths book available to you readable? (Group I and Group II)

Number of responses	66
Yes, I can understand all topics without struggling much.	11
No, I cannot understand anything until someone reads them to me.	18
Partially, I can follow but it is a small and often I get stuck.	37

How are available books not accessible to you? Select all that apply. (Group I and Group II)

Number of responses	66
The text part is okay but the numerical portions are not readable.	35
Figures and diagrams are unavailable. This limits my access. Do not have text descriptions.	48
I find it difficult to navigate through tables.	4
I cannot read charts and graphs.	44
Reading Maths books takes much more time then usual.	30
My Maths books is completely accessible to me and I do not face any problems while reading them.	6

Do you have access to a Geometry kit or tactile board? (Group I and Group II)

Number of responses	66
Yes	45
No	21

If the above answer is Yes, do you use them for construction while solving problems?

I use them occasionally to understand certain concepts.	18
I use them occasionally to understand certain concepts.	16
I do not know how to use them but my teachers sometimes use them to explain the diagrams.	6
I use them occasionally to understand certain concepts.	5

Do you have tactile diagrams of the figures of each chapter separately?
(Group I and Group II)

Number of responses	66
Yes, I refer to them while reading my book.	21
No, I do not have such diagrams and I struggle with figures.	45

5.3 Science

Which of the following topics is comparatively hard for you? (Group I and Group II)

Number of responses	66
Physics	26
Chemistry	32
Biology	8
Environmental Studies	0

Are you able to follow your Science textbook and understand all topics? (Group I and Group II)

Number of responses	66
Yes, I can understand all topics without struggling much.	30
No, I cannot understand anything until someone reads it to me.	4
Partially, I can follow but I often get stuck.	32

Do you have tactile diagrams of the figures of each chapter separately? (Group I and Group II)

Number of responses	66
Yes, I refer to them while reading my book.	24
No, I do not have such diagrams and I struggle with figures.	42

Do you get to perform all your practices and experiments in your science lab? (Group I and Group II)

We perform all the experiments listed in the book.	17
We perform most of the experiments but not all.	12
We occasionally go to our labs and perform only a few experiments.	29
We do not have access to the Science lab.	8

Over time, there has been a noteworthy enhancement in the accessibility of digital study materials, particularly in the realm of Mathematics and Science. The incorporation of LaTeX-like structured formats, as opposed to image-based content, has significantly eased the process of reading symbols and complex equations through screen readers.

Organisations such as Bookshare, Sugamya Pustakalaya, Blind to Visionaries, Vision Empower, Raised Line Foundation and other proactive teams have emerged as key contributors in converting curriculum textbooks into accessible, screen-readable formats.

These accessible books are readily downloadable from their respective portals, providing valuable assistance to visually impaired students.

While the manual conversion of textbooks to accessible formats marks a commendable initiative, it raises a pertinent question: Who will take the responsibility of keeping these accessible books updated amidst the continuous changes introduced in the syllabus and textbooks? This question becomes particularly salient in the context of the recent implementation of the National Education Policy (NEP) in 2020 and the coming changes. Addressing this concern is pivotal to ensuring that visually impaired students have access to current and relevant educational resources, aligning with the dynamic landscape of educational policies and syllabi.

5.4 Role of the teachers

While studying in your class, can you easily follow the concepts demonstrated by your teacher?

Number of responses	66
Yes, I can follow my teachers and understand most of the concepts.	39
No, I cannot understand much unless someone individually explains it to me.	27

In Maths and Science subjects, does your teacher cover all the chapters thoroughly?

Number of responses	66
Yes, the entire syllabus is taught to us.	52
No, some of the chapters/topics are skipped.	14

Do you take extra classes/tuitions for Maths and Science other than your school classes?

Yes	52
No.	14

The challenge of securing a dedicated cadre of teachers proficient in instructing Mathematics to visually impaired students remains a persistent concern for special schools. This issue significantly contributes to the difficulty students face in building confidence and mastering foundational concepts, hindering their preparedness for higher education.

An illustrative example of this challenge is evident in one of the initiatives introduced by the Department of Empowerment of Persons with Disabilities (DEPWD) team in May 2023. The initiative aimed to bolster STEM education in Classes 11 and 12 for students with disabilities by establishing science labs in special schools catering to blindness and hearing impairments.

To engage national institutes, approximately 100 proposals were dispatched nationwide. Regrettably, the response yielded only four or five nominations. Subsequent discussions with schools revealed a critical factor contributing to this lack of interest: the dearth of dedicated and trained teachers specifically qualified to undertake responsibilities at the Class 11 and 12 levels. This scarcity underscores the imperative need for targeted efforts to address the shortage of qualified educators in specialized areas, ensuring the seamless advancement of visually impaired students in STEM education.

5.5 Compatibility with Scribes

Do you take the help of a scribe to write your exams?

Number of responses	98
Yes, I take the help of a scribe to write all my exams.	52
I take the help of a scribe but only for a few subjects.	22
No, I write all my exams.	24

Do you experience any of the following challenges while taking your exam with a scribe? Select all that apply.

Mismatch of pace: I experience an unbalanced situation while dictating. Either I speak faster and the scribe writes slow or vice versa.	59
Familiarity with terms: While dictating, I need to use some jargon for symbols and equations that my scribe cannot understand in one go.	72
Discussion on diagrams: Many times, we both struggle to explain the diagrams to each other.	78
Cannot say much as I have never taken the help of a scribe.	29

Scribe Assistance for PWD Candidates

In the realm of competitive exams, some PWD candidates, particularly those with visual impairment, require the aid of a scribe for writing or marking their answers. Guidelines from the Ministry of Social Justice and Employment grant candidates the option to either bring their scribes or request one from the exam-conducting body. However, a concerning trend emerges at the state level, where violations of these guidelines are observed. Individuals or some group of scribes exploit loopholes, offering preparation services for candidates, often charging exorbitant fees ranging from Rs 20,000 to 500,000. While candidates from affluent backgrounds may benefit, those from economically disadvantaged backgrounds face financial burdens despite their sincere efforts.

The genesis of this issue lies in the lax implementation of existing laws. Bodies responsible for enforcing these laws claim ignorance of such practices across different examination centres. Calls for the establishment of an active national scribe forum have been made, aiming to provide quality scribes and thwart exploitative practices. Discussions on modifying exam patterns for visually impaired candidates have also been proposed to enhance their independence in preparation, reducing reliance on paid scribes.

Case-Based Evidences

Despite the Rights of Persons with Disabilities Act 2016 guaranteeing equal participation with reasonable accommodation, a 2022 Supreme Court case against the National Testing Agency exemplifies the gap between legislation and reality. In this case, a candidate with a disability,

Sheela (name changed), did not receive the entitled extra hour due to administrative confusion and the center's negligence. The court emphasized the duty of competent authorities to provide reasonable accommodation for all candidates with disabilities to maintain an inclusive setup.

Dev's IBPS Clerk Exam 2022

Dev, a visually impaired candidate, arranged a scribe for the IBPS Clerk Exam 2022. During the exam, an invigilator abruptly prevented the scribe from using a rough sheet for calculations, ignoring the candidate's plea. The incident raises concerns about unjust implementation and the need for clear communication of guidelines to all exam-conducting bodies.

Garv's JEE Mains Challenge:

Garv, a visually impaired student, appeared for the 2022 JEE Mains exam, relying on the assistance of a scribe. The examination centre did not permit him to bring his scribe and assigned him one instead. The appointed scribe, lacking a background in Mathematics, struggled to read symbols and equations and explain diagram-based questions, creating a significant disadvantage for Garv. Despite Garv's efforts to bring this issue to the attention of the examination centre's superintendent, his concerns were overlooked. This case underscores the importance of adherence to NTA guidelines, which stipulate that the scribe should be one level below the candidate and must have Mathematics as one of his core subjects. The incident exemplifies the challenges candidates face when examination centres are unaware of, or fail to comply with, specified provisions, resulting in undue difficulties for visually impaired candidates.

Kavita's JEE Advanced Experience:

Kavita (name changed), a visually impaired student, faced challenges during the JEE Advanced exam, which consisted of diagram-based questions. Relying on a scribe, Kavita found it difficult to navigate the visual content, impacting her performance. Her hesitation to communicate during the exam and her preference for a same-gender scribe underscore the need for inclusive practices.

Conclusion

The challenges faced by PWD candidates in accessing appropriate scribe assistance reveal systemic gaps in the implementation of laws and guidelines. Addressing these issues requires proactive measures, including the establishment of national forums, modification of exam patterns, and inclusive practices to ensure a level playing field for all candidates, regardless of their physical abilities or financial backgrounds.

5.6 Pandemic era

During the pandemic, were you getting all your classes in online mode? (Group I, Group II and Group III)

Number of responses	98
Yes, we got all our classes as per the schedule.	86
No, we did not get to attend any class.	3
We were getting classes but at a lesser frequency.	9

How did that online mode of education affect your studies?

It made our job easy as we started using electronic study materials and got access to recorded lectures.	31
It was not that suitable as we did not get a physical demonstration of the concepts.	59
I do not observe any change. Everything was as before.	8

Did you observe any significant improvement or deterioration in your performance during that shift?

Number of responses	98
Yes, it improved.	31
No, it deteriorated.	32
No significant change. It remained as it was.	35

5.7 Barriers due to the medium of instruction

If your medium of instruction is Hindi, do you realise that it would have been easier to grasp Maths and Science concepts if it was English?

Number of responses	44
Yes, I think English would have been more useful as related resources are easily available and we wish to pursue these subjects in higher classes.	29
No, Hindi is equally compatible. I find it hard to follow the concepts in English.	15

5.8 Career perspectives

Do you wish to opt for STEM as a field for your career?

Number of responses	66
Yes, I aspire to learn tech and contribute through top MNCs or establish my ideas as a startup.	39
No, rather I would like to work in a government job or prepare for UPSC.	19
Cannot say anything for now. I will decide later.	8

5.9 Accessibility on school premises

Are you able to independently commute through your school premises?

Yes.	34
I can, but only in some areas.	25
No, I need someone to accompany me.	7

In the context of promoting accessibility within school premises, this case study sheds light on the challenges faced by students with locomotor disabilities in pursuing Mathematics and Science subjects in a regular school in New Delhi (name not mentioned due to confidentiality). The school, grappling with financial constraints, encountered difficulties in accommodating these subjects for students with mobility impairments.

The practical labs, essential for Physics and Chemistry experiments, were situated on the first and second floors, rendering them inaccessible to students with locomotor disabilities due to the absence of ramps and elevator facilities.

Faced with financial constraints, the school sought an alternative solution in the absence of immediate elevator or ramp installation. Through collaborative efforts, a practical approach was devised: teachers would bring down the necessary equipment to the students, enabling them to conduct experiments on the ground floor. This pragmatic workaround facilitated student participation in practical activities despite the infrastructure challenges.

This scenario prompts critical questions for consideration:

If students are hindered from pursuing certain subjects due to accessibility issues, what alternative options are available for them?

In instances where institutions face financial constraints in establishing an accessible infrastructure, where can they seek assistance for resolving such challenges?

5.10 View of students from Class 9 and above who did not pursue Maths or Science subjects

What do you think was the main reason behind you not pursuing Maths and Science subjects up to your current grade?

Does your school provide an option to pursue Maths and Science Class 9 onwards?
Do you believe that quitting Maths and Science subjects right after Class 8 will have an impact on your upcoming education and career in some way?

Sunil's Dilemma
Sunil (name changed), a visually impaired professional working as an accessibility tester, aspires to transition into a core development role and explore new opportunities. However, he faces a common yet significant hurdle – the mandatory requirement of Mathematics in educational backgrounds, typically till the 10th or 12th grade.

In pursuit of advancing his career, Sunil encounters challenges when applying for professional degree courses like BCA/MCA. Many reputable universities maintain strict criteria, demanding a consistent background in Mathematics. This criterion extends to job applications where resume shortlisting becomes a potential roadblock for individuals lacking a Maths background beyond a certain academic level. Sunil's experience exemplifies the broader issue faced by many individuals across the country. Their aspirations for career growth and educational pursuits are hindered by rigid prerequisites, highlighting the pressing need for a more inclusive approach to recognising the diverse paths individuals may take in their STEM education journey.

5.11 Open comments

Would like to learn through STEM.
Looking forward to joining IIT Delhi in a year, aiming to clear JEE Mains with a good enough rank.
Wonderful initiative. Happy to be a part. Would like to stay in touch and be informed of any developments. Thank you for doing this.
नमस्ते! सर्वप्रथम तो मैं आप सभी का, जितने भी इस सर्वे को आयोजित करने में सहभागी है, बहुत-बहुत धन्यवाद. यह एक नई दिशा में एक नई सोच की ओर एक नए परिवर्तन के तौर से अगर देखा जाए तो बहुत अच्छा कदम है. मेरी आशा है और दुआ भी कि आप लोग इस और बहुत लगन और मेहनत से काम करें तथा ध्यान दें और जहां तक संभव हो, इस योजना को सफल बनाएं. शुक्रिया.
I liked the questions asked in the survey.
I have experienced one thing which I want to tell you. Those children who were able to learn Braille did not learn it. This time when the school opened, I felt that he was in fifth and sixth grade. But they do not know anything.

6. Discussion

Our study unraveled prevalent challenges confronted by visually impaired students in accessing Mathematics and Science content. Notably, there is a discernible decline in interest in these subjects as students' progress to higher classes (9 and above), emphasizing the need for targeted interventions.

In Mathematics, a significant majority (over 80%) of students identified Geometry as particularly challenging compared to other topics. This highlights a specific area where tailored support may be beneficial.

Various study methods were employed, including Braille tools, technical devices, large-print books, geometry kits, and tactile boards. In early classes, more than 60% of students utilized Braille-related tools, whereas, in higher classes, this proportion diminished to approximately 20%, indicating an increased reliance on technical devices. However, issues related to the readability of class textbooks persisted, with deficiencies in diagram descriptions, maths content clarity, and navigation options. Consequently, students often resorted to external assistance or manually prepared notes.

Approximately 40% of students reported difficulty comprehending concepts presented in class, leading many to seek extra classes for clearer understanding. Furthermore, 50% of students took a scribe during exams, while others utilized laptops or sought scribe assistance selectively.

The transition to online education posed challenges for about 70% of students, citing the absence of physical demonstrations of concepts. Additionally, 60% of students expressed a belief that English as the medium of instruction would enhance their grasp of Mathematics and Science concepts by providing broader access to resources.

Students who discontinued Mathematics and Science early faced constrained career options, particularly evident in the struggle to secure IT sector jobs despite possessing technical proficiency. Reasons cited included a lack of motivation, inadequate support from teachers and parents, limited accessible resources, and challenging financial and geographical conditions.

Half of the students aspired to pursue STEM education in higher classes and contribute to the tech sector. Meanwhile, 26% expressed a desire for government jobs, while the remaining 24% remained uncertain about their future career paths. These aspirations underscore the importance of addressing challenges early on to facilitate a more inclusive and diverse participation in STEM fields.

7. Conclusion

In culmination, this study sheds light on the persisting access barriers confronting blind and visually impaired students in the realm of Mathematics and Science. Our findings illuminate the most prevalent barriers and elucidate their consequential impact on the lives of these students.

We underscore the transformative potential of a robust accommodation strategy coupled with unwavering support systems. The removal of existing limitations is not only conceivable but imperative for fostering success in the academic journey of visually impaired students in Mathematics and Science. It is a resounding affirmation that blindness should not be a hindrance to the acquisition of knowledge across diverse fields when equipped with the requisite tools and support.

A significant player in this equation is assistive technology—tools that can make learning easier for both blind and sighted students. Organisations are already utilising these tools, and more students are venturing into STEM subjects as a result. This indicates a positive trend for the future.

In conclusion, we envision a future where visually challenged students can excel in STEM, contributing to a more accessible and inclusive world. Achieving this vision requires collaborative efforts, ongoing research, and a steadfast commitment to breaking down barriers. We aim for education to be a wellspring of opportunity for everyone, regardless of their visual abilities.

8. Annexure and References

Survey questionnaire: Survey questionnaire

1. “Accommodating Students with Disabilities in Science, Technology, Engineering and Mathematics (STEM), 2012 by Moon et al.
2. (Gulley, Smith, Price, Prickett & Ragland, 2017)
3. (Smith & Smothers, 2012)
4. Klingenberg, Fosse & Augestad, 2012
5. Supalo et al., 2014)
6. Teaching Maths and Science to students with visual challenges
7. Science adaptation for students who are blind or visually impaired
8. [8] Science learning for students with visual challenges
9. [9] Reflection of a visually impaired technician

Please add a summary of the questions asked as you have already mentioned the questions in detail in the survey results as well as attached the questionnaire in the annexure.

www.ncpedp.org 011 2622 1276 @ncpedp_india