Academic Challenges of Blind Students and Their Mitigation Strategies[1]

Research-in-Progress

Shrirang Sahasrabudhe
University of North Carolina at Greensboro
s_sahasr@uncg.edu

Prashant Palvia
University of North Carolina at Greensboro
pcpalvia@uncg.edu

ABSTRACT

In the knowledge driven world, quality education is an absolute necessity in order to succeed and advance. Most of the current educational curriculum is oriented towards the use of the eyesight. This requirement poses paramount challenges to the blind and visually impaired (BVI)[2] students. This paper undertakes a qualitative and subsequent quantitative inquiry to understand the academic challenges faced by BVI students in high school and college, their resolution strategies and the use of technology to resolve their problems. The pilot study and the subsequent survey identify the extent of visual disability, knowledge of Braille, availability of materials in Braille, availability of alternative formats such as tactile models, availability of human assistance reader/scribe, affordability of the solution technology and perceived use of the solution technology as antecedents for the choice of the resolution strategy.

Keywords

Blind students, Visually impaired, Academic challenges, Education, Mitigation strategies

INTRODUCTION

The world today is powered by technology, fueled by information and driven by knowledge. Knowledge is the currency of modern life, and quality education for all is a necessity and not an option. Humans are gifted with five senses: vision, hearing, touch, taste and smell. As far as educational setting is concerned, most of the curriculum presumes that the student has perfect eyesight. Therefore most of the educational curricula tend to be eyes-intensive, which makes eyesight as an important feature to take full advantage of educational opportunities.

There are an estimated 19 million blind children worldwide (WHO, 2012). Approximately one child goes blind every minute in the world, making a total of 500,000 children who go blind each year in the world. In the US alone, the number of school children who are blind is estimated to be more than 485,500 (NFB, 2012). Studies suggest that school kids are increasingly getting used to tobacco consumption which can cause blindness (Gazmararian, et al. 2007). All these students are essentially print-disable (i.e., a person who cannot effectively read print because of a visual, physical, perceptual, developmental, cognitive, or learning disability) or progressively would become print-disable. As we move ahead in this knowledge driven economy, we cannot afford to keep this large group of individuals deprived of quality education.

With the inception of assistive technologies like screen-reader BVI individuals are getting empowered like never before. Technology is helping them to absorb information and leverage technology to resolve their day-to-day challenges. They are able to access information and are able to communicate their thoughts with the sighted world. Innovations in the field of educational technology such as "Audio Math" (Sánchez and Flores, 2005), tactile graphics (images those use raised surfaces so that BVI individuals can feel them) are opening new avenues for the BVI individuals.

Though the picture appears to be quite rosy, inaccessibility of learning materials (Sahyun et al., 1998), and increasing focus on visual curriculum, poses paramount challenge to the information revolution. Therefore it is imperative to understand and appreciate the challenges faced by visually impaired students in academic setting and various strategies utilized by them to mitigate the challenges.

[1] A preliminary version of this paper was prepared for another conference. This version includes the survey results as well as an expanded discussion.
[2] The first author of the paper is a completely blind student. This paper, therefore, itself reflects challenges faced by the BVI students.

This study attempts to create taxonomy of these challenges and respective strategies/solutions employed by the students to be successful and effective in the academic career. This study specifically focuses on challenges faced and strategies used by BVI individuals in India.

RESEARCH DESIGN AND METHODOLOGY

To gain an understanding of the academic challenges encountered, and respective problem solving strategies employed by BVI students, we conducted qualitative interviews with five blind individuals from India. We employed a "General Interview Guide Approach" to interview the students. The questions were intentionally kept open-ended to capture the student's real-life academic experiences. Three of the subjects were completely blind and the remaining two had low vision.

The interviews were recorded in "Marathi" language, and were later translated into English by the first author of this paper. The subjects belong to diverse socio economic strata. All the five subjects have completed their high school and college education in India. One of the students has completed a master's degree in computer management, two of the students are pursuing master's in computer management and the other two have completed Bachelors in Arts. Currently four of them are working as software developer at TechVision (a software firm under the umbrella of Nivant Andh Mukta Vikasalaya).

The interviews were followed by mail survey questionnaires send to many BVI students. The survey details are provided later.

THE INTERVIEWS

Participant P1:

P1 is partly sighted. He received high school education in a regular school along with sighted peers. He studied both Science and Math up to 10^{th} grade level. In classroom, he faced difficulties reading the text written on white board. The teachers generally read aloud the text on request. If he missed any information from the teacher's narrative, his peers used to explain it to him. And whatever was still unclear was taught to him by his parents. Although his vision was quite blurred, in earlier standards he used to read books himself. He used a simplistic workaround and utilized a magnifying glass to enlarge the print material so that he could perceive it. That was a very primitive and time intensive strategy. Therefore, as he moved up the educational ladder, he started getting study material read and recorded primarily by the volunteers at non-government organizations working for blinds within Pune city. As a response to the question, "Why did not you use Braille?" he said, "Because I did not know Braille". Also he mentioned that "drawing diagrams was a concern but comprehension was never a concern".

Another challenge he referred to was evident during writing and taking notes in the classroom. Through first few grades, he used a magnifying glass while writing in a notebook. But as he moved to high school, he could not keep pace with the writing. Subsequently he started borrowing notes from peers. He used to photocopy the notes, and got them recorded by volunteers. On account of deteriorating vision from 9^{th} grade onwards, he relied on a scribe (another individual) to write examination papers.

He also faced challenges while learning Geometry. He reiterated the use of enlarged diagrams while grasping the concepts in Geometry. He also alluded to a home-grown workaround of using a chessboard and a woolen thread to create raised geometry figures. On probing "so you never used tactile graphics", he mentioned the use of "tactile graphics" at college level for understanding graphs and charts in Economics.

He referred to difficulties faced while learning Science (Physics, Chemistry and Biology). The primary difficulty was with conducting lab experiments. He never conducted any lab experiments himself, but teachers and peers demonstrated the experiments to him. He understood only the procedure and the scientific principle underpinning the experiment. During the course of the interview, he mentioned the detail procedure of the experiment for refraction of light. He also briefly mentioned the use of a model to learn structure of an atom and molecule.

He mentioned the use of an audio cassette recorder and player as the only technology solution used by him throughout his high school education. Although he was aware of tools like screen reading software, scanning and reading device etc., he could not use the tools successfully. And he said, he preferred proven and quicker solutions to emerging technology solutions.

Participant P2:

P2 is completely blind since birth. He received primary education till 4^{th} grade in a blind school. From 5^{th} grade onwards he studied in a regular school with sighted peers. He studied science and math up to 7^{th} grade.

At the blind school, in the very beginning, he was taught to read and write Braille. He said that he used to get books from the school library. But rarely, books for all subjects were available. Also the Braille books used to be bulky and hence cumbersome to handle. Therefore from 5^{th} grade onwards, he depended on volunteers available with the school to read and record the study material on audio cassettes. He also mentioned that, in early years of high school, everyone did not have a cassette player and replication of cassettes was not easy for the students. Therefore multiple BVI students used to listen to the cassette together.

In the context of Math and Science, he mentioned that, till 4th grade, the instructor read the Math book to the students and he was never required to read a Braille Math book. He mentioned the use of Braille Math Slate, to solve Math problems. He also admitted that, the quality of education in the school was low and most of his studies depended upon memorizing the information in the books. He also said that, he never conducted any science experiments and his knowledge of science is as good as nothing.

He got introduced to computer and screen reading technology after joining college post 12th grade. He mentioned, he attempted, scanning printed material and reading it on computer. But the optical character recognition (OCR) technology was not up to the mark. He had to spend lot of time in correcting the errors in the scanned text. He mentioned that even the volunteers and friends used to get irritated editing the documents. Consequently he did not use the scanning and reading technologies.

Another unique problem mentioned by P2 was, that he studied in Marathi medium and the OCR solution for "Marathi" language was not in existence.

Participant P3:

P3 is completely blind since the age of nine. After losing eyesight in an accident, he had to switch to a blind school, where he learned Braille. He studied Science and Math till 7th grade only. He specifically mentioned that the blind school officials did not allow him to take up Science and Math beyond 7th grade. He was forced him to study lower grade Math and Science. When asked about use of any tactile representations, he mentioned only couple of instances when the school instructor presented a raised Map of India and Maharashtra state.

Throughout his high school education, he solely depended upon volunteer readers and audio cassettes. During college education he got access to a laptop computer equipped with screen reading software, and since then he is using the laptop as a primary note taking and studying device. He also alluded to use of Sara scanning and reading machine available at Nivant NGO. He mentioned that the Nivant NGO played a crucial role in supporting him in his academic endeavors.

He mentioned that he had never conducted Science experiments. But the instructors had introduced him to the lab apparatus. He also said that tactile models of scientific concepts such as atom, molecule, and human anatomy were helpful for him to understand the concepts.

P3 suggested that, interviewing a blind village student would be helpful as in villages, conditions are far worse. And consequently those students have to struggle a lot to get education. He mentioned that, there is a huge difference between the development of blinds in higher class and middle or lower class.

Participant P4:

P4 is completely blind since birth, and up to 4th grade studied in a blind school. He studied Science till 10th grade and Math till 7th grade. He learned Braille. He mentioned that the primary challenge with Braille material was that it was very limited. Also in case of Math and Science, the teachers never let him participate in the labs. So all the Science studies were done through memorizing, and hence it was very difficult to grasp Science concepts. He also mentioned that Math equations were especially hard to learn.

He used a Braille slate for taking notes and for writing assignments. The only technology he used during high school was a cassette recorder. He got introduced to computers in the 11th grade; later in college education, he started using computer as the primary educational tool.

When I probed about how did he deal with diagrams, his response was "Drawing diagram and all was totally out of question". He recollected that only in a single instance, his instructor introduced him to different categories of triangles using a spur wheel.

Participant P5:

P5 is partly sighted. In the place he was born, there was no school for the blind, and hence he started studying in a regular school. But soon, he relocated to his uncle's place and joined a residential blind school. He mentioned that, he could not take notes himself, and he did not have any recording technology at his disposal. He also knew Braille, but he used his slight vision to read printed material. He sadly mentioned that at his village, no volunteers were available to read books to him. Since he has moved to Pune, the Nivant NGO is providing complete support to him and now he is successfully pursuing his Master's degree.

THE SURVEY AND ANALYSIS

We transcribed the interviews into text for further analysis. We ascertained the validity of the transcription by verifying it with the interview participants. We manually coded the interview responses on the basis of the academic activity referred by the participant while describing the challenges they faced. The interviews yielded the following four academic activities where student faced challenges due to their disability condition. The academic activities were:

a. Reading
b. Writing
c. Learning Math
d. Learning Science

In order to validate our interview findings for a larger population, we designed an online survey on the basis of these academic activities. The survey captured information about the challenges faced and resolution strategies employed by the BVI participants while accomplishing the above four activities. The online survey was distributed to BVI individuals in India. The questions were deliberately kept open-ended in order to receive descriptive and insightful answers. Adequate screen-reader accessibility of the online survey web interface was ensured. However for the individuals who reported difficulty completing the survey using screen-reader were provided with an excel spreadsheet with the same questionnaire. We were interested in finding out if there were any significant differences in challenges and strategies over a period of fifteen to twenty years. Therefore we distributed the survey to individuals in different age groups. However due to low response rate, we could not determine whether there were any such significant differences.

We attempted to reach 50 students, and received a total of 27 responses. Of these, 74% were completely blind and 26% reported having low vision. Only one respondent reported having slight difficulty in hearing along with the blindness. 92.6% of the respondents were male. 3.7% respondents belonged to the age group 10 to 15 years, 7.4% were from the age group 16 to 20 years, 40.7 % were in the age group 20 to 25 years, 18.5% in age groups of 25 to 30 years and 30 to 35 years each, and 11.1% respondents were above 35 years of age. 87% of the respondents had completed their Bachelor degree while rest of the respondents was pursuing some college program.

Summary of the issues

Table 1summarizes the academic challenges faced by the BVI interviewees and the survey respondents.

Table 1. Academic Challenges

Academic activity	Issue	Description	Cause
Reading	cannot read the printed material	reading the printed material was not possible	complete blindness
Reading	difficulty reading the printed material	reading the printed material was difficult and time consuming	partial blindness
Reading	cannot read the information written on whiteboard	reading the information written on whiteboard was not possible	complete blindness
Reading	difficulty reading the information written on whiteboard	reading the information written on whiteboard was difficult and time consuming	partial blindness
Reading	cannot read the Braille material	reading the material in Braille was not possible	unavailability of Braille material, lack of proficiency with Braille, bulky nature of Braille material
Reading	Cannot read the electronic material in Marathi	Reading the electronic material in regional languages was not possible	Unavailability of Text to Speech solutions for supporting regional languages in India
Writing	cannot take in-class notes	writing with pen and paper was not possible	inability to write using pen and paper, lack of Braille proficiency, lack of access to computer and screen reading technology
Writing	difficulty taking notes	writing with pen and paper was difficult and time consuming	partial blindness, lack of Braille proficiency, lack of access to computer and screen reading technology

Writing	cannot write exam	writing with pen and paper was not possible	inability to write using pen and paper, Braille was not allowed as a answering medium, lack of access to the computer and screen reading technology
Writing	difficulty writing exam	writing with pen and paper was difficult and time consuming	partial blindness, lack of Braille proficiency, lack of access to computer and screen reading technology
Learning Science	cannot grasp Science concepts	understanding science concepts was difficult and time consuming	visual nature of the curriculum, unavailability of study material in alternative formats, unavailability of tactile models, negative attitude of school instructor
learning Science	cannot conduct Physics experiments	using lab apparatus was not possible	visual nature of the task, unavailability of technology solutions, negative attitude of school instructor
Learning Science	cannot conduct Chemistry experiments	using lab apparatus was not possible	visual nature of the task, unavailability of technology solutions, Risk involved whiling handling Chemicals, negative attitude of school instructor
Learning Science	cannot conduct Biology experiments	using lab apparatus was not possible	visual nature of the task, unavailability of technology solutions, negative attitude of school instructor
Learning Math	understanding Geometry concepts	understanding Geometry concepts was difficult and time consuming	visual nature of the curriculum, unavailability of technology solutions, negative attitude of school instructor
Learning Math	drawing Geometric figures	drawing Geometric figures was not possible	visual nature of the task, unavailability of technology solutions
Learning Math	understanding co-ordinate Geometry	understanding co-ordinate planes was difficult	visual nature of the curriculum, unavailability of technology solutions, negative attitude of school instructor
Learning Math	Difficulty solving Math problems involving calculations.	difficulty carrying out Mathematical operations on large numerals	unavailability of technology solutions
Learning Math	Difficulty grasping accounting problems in Commerce courses.	Difficulty in visualizing the tabular structures of accounts made it difficult to grasp the problem and to solve it	Blindness

Summary of Resolution Strategies

Table 2 summarizes the resolution strategies employed by the BVI interviewees and the survey respondents.

Table 2. Resolution Strategies

Issue	Resolution Strategy
cannot read the printed material	use of Braille, human reader, audio cassettes, scanning and reading software
difficulty reading the printed material	use of Braille, use of magnifying glass
cannot read the information written on whiteboard	instructor or peer narration
difficulty reading the information written on whiteboard	sitting close to the whiteboard
cannot read the Braille material	human reader, audio cassettes, scanning and reading software
cannot take in-class notes	Braille slate, use of laptop computer with screen reading software
difficulty taking notes	use of magnifying glass, use of laptop computer with screen reading software
cannot write exam	human scribe
difficulty writing exam	use of magnifying glass
cannot grasp Science concepts	memorization of the instructor's narrative, use of tactile models
cannot conduct Physics experiments	sighted assistant to carry out the procedure, instructor's and peer's narration of the procedure
cannot conduct Chemistry experiments	sighted assistant to carry out the procedure, instructor's and peer's narration of the procedure
cannot conduct Biology experiments	mere theoretical understanding
understanding Geometry concepts	enlarged diagrams, home-grown workaround of using a chessboard and a woolen thread to create raised geometry figures, tactile graphics
drawing Geometric figures	spur wheel
understanding co-ordinate Geometry	Home-grown workaround of using a chessboard and a woolen thread to create raised tactile coordinate planes, use of spreadsheet application row/column structure to understand co-ordinate system.
difficulty solving Math problems involving calculations	Math slate/ Taylor Frame, Abacus, talking calculator
Difficulty grasping accounting problems in Commerce courses.	Use of spreadsheet application with the screen reader software

DISCUSSION AND INTERPRETATION

It is to be noted that many of the strategies used by the students are very primitive. With the use of computer and information technology, more innovative and easier solutions can be found. While some technologies exist, such as screen readers, "Audio Math" (Sánchez and Flores, 2005), we have a long way to go to completely enable the BVI students. The next challenge is to develop such technologies based on the needs described above, and bring them to the masses efficiently and cheaply.

The analysis suggests that, there are multiple determinants of the choice of the resolution strategy. The determinants are: extent of visual disability, knowledge of Braille, availability of material in Braille, availability of tactile models, availability of human

assistance vs. readers/scribes, affordability of the solution, and perceived usefulness of the solution. The following Tables (3 to 6) summarize these determinants and their relevance for each of the resolution strategies.

Table 3. The determinants for "reading" activity

activity	chosen resolution strategy	extent of visual disability	Knowledge of Braille	Availability of the material in Braille format	availability of human assistance/reader	affordability of the solution	perceived usefulness of the solution
reading	use of Braille	Y	Y	Y	N	Y	Y
reading	Human Reader	N	N	N	Y	Y	Y
reading	audio cassettes	N	N	N	N	Y	Y
reading	scanning and reading software	N	N	N	N	Y	Y
reading	use of magnifying glass	Y	N	N	N	Y	Y
reading	instructor or peer narration	N	N	N	N	Y	Y
Reading	sitting close to the whiteboard	Y	N	N	N	N	N

Table 4. The determinants for "Writing" activity

activity	chosen resolution strategy	extent of visual disability	Knowledge of Braille	Availability of the material in Braille format	availability of human scribe	affordability of the solution	perceived usefulness of the solution
writing	Braille slate	Y	Y	N	N	Y	Y
writing	use of laptop computer equipped with screen reading software	N	N	N	N	Y	Y
writing	use of magnifying glass	Y	N	N	N	Y	Y
writing	human scribe	Y	N	N	Y	N	N

Table 5. The determinants for "Learning Science" activity

activity	Chosen resolution strategy	extent of visual disability	Knowledge of Braille	Availability of the Tactile models	availability of human assistance	affordability of the solution	perceived usefulness of the solution
learning Science	memorization of the instructor's narrative	N	N	N	N	Y	Y
learning Science	use of tactile models	Y	N	Y	N	Y	Y
learning Science	sighted assistant to carry out the procedure	N	N	N	Y	Y	Y
learning Science	instructor's and peer's narration of the procedure	N	N	N	Y	Y	Y
learning Science	mere theoretical understanding	Y	N	N	Y	Y	Y

Some additional comments are in order. The subjects reported that, during high school, the use of technology was limited to audio recording, Braille slate, Taylor Arithmetic Frame and magnifying glass. It was observed that the individuals with partial visual impairment tend to rely on their available eye-sight up to the extent possible. It is suggestive of the need of considering the "extent of visual disability" in conducting BVI research and while designing the study materials and assistive technology. It was also evident that, some of the respondents did not use any special techniques, and tried to learn with the help of the instructor's narrative and help of the peers. This may indicate a lower awareness levels about the available technological solutions.

The choice of the resolution strategy was determined by multiple factors. The factors were: extent of visual disability, knowledge of Braille, availability of material in Braille, availability of alternative formats such as tactile models, availability of human assistance reader/scribe, affordability of the solution and perceived use of the solution. What surprised us was the limited use of information technologies by these students. One possible reason for this finding may be the limited availability of such technologies in India (a developing country) and in rural areas, and their associated costs.

Table 6. The determinants for "Learning Math" activity

Activity	chosen resolution strategy	extent of visual disability	Knowledge of Braille	availability of tactile models	availability of the human assistance	affordability of the solution	perceived usefulness of the solution
Learning Math	enlarged diagrams	Y	N	N	N	Y	Y
Learning Math	home-grown workaround of using a chessboard and a woolen thread to create raised geometry figures	N	N	N	N	Y	Y
Learning Math	tactile graphics	N	N	Y	N	Y	Y
Learning Math	spur wheel	N	N	N	N	Y	Y
Learning Math	Use of spreadsheet application row/column structure to understand co-ordinate system.	N	N	N	N	Y	Y
Learning Math	Math slate/ Taylor Frame	N	N	N	N	Y	Y
Learning Math	Abacus	N	N	N	N	Y	Y
Learning Math	Talking calculator	N	N	N	N	Y	Y

LIMITATIONS AND FUTURE DIRECTIONS

The primary limitation of the study is the small sample size of the survey. Also the levels of diffusion of assistive technologies for the BVI vary from nation to nation. Access to advanced assistive technology in the US, in India and in the third world countries tend to differ widely. In fact the levels of diffusion of technology within India as a nation are also significantly unequal; therefore it is difficult to generalize the issues and strategies for entire BVI community. However it would be interesting to compare issues and resolution strategies of the BVI students from the developed, developing and under-developed nations.

CONCLUSION

In this study, we attempted to gain an overall understanding of the academic problems faced by the BVI individuals as a result of their blindness condition while pursuing high school education in a developing country and their resolution strategies. As a pilot study, we conducted five qualitative interviews with BVI students. The qualitative study was followed by a survey of BVI individuals. Students reported four academic activities where they faced challenges: reading, writing, learning Math, and learning Science. The use of technology was limited to audio recording, Braille slate, Taylor Arithmetic Frame and magnifying glass. Some respondents did not use any special techniques, and tried to learn with the help of the instructor's narrative and help of

peers. The choice of the resolution strategy was determined by multiple factors: extent of visual disability, knowledge of Braille, availability of material in Braille, availability of alternative formats such as tactile models, availability of human assistance reader/scribe, affordability of the solution and perceived usefulness of the solution. What surprised us was the limited use of information technologies. One possible reason may be the limited availability of such technologies in under-developed and developing countries and in rural areas.

In conclusion, information technologies have much to offer. Not only the technology solutions need to be developed in areas they do not exist, but they also need to be made accessible and affordable. Thus, assistive technologies for the BVI is a formidable area to address by both socially responsible practitioners and researchers. It seems evident that affordable technology, educated parental support and progressive non-government organizations can positively influence the state of BVI education in India and elsewhere.

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