MATHEMATICS EDUCATION FOR BLIND: CURRENT SCENARIO FROM THE BLIND SCHOOLS IN BANGLADESH

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Abstract: *The learning process for the blinds is complicated as they are unable to get visual information. They only depend on touch and haring to get the education. Bangladesh is a low-income country with a huge number of blind children. Including special, integrated and inclusive schools are available for blind students in Bangladesh. A lot of challenges and problems these blind children are facing to get education, especially in studying Mathematics. As a developing country, Bangladesh cannot afford for the costly Mathematics learning technological tools for VIS. The objective of this study is to analyze the current scenarios of learning Mathematics in different types of blind schools in Bangladesh. In order to achieve the objective, a survey is conducted in all three types of schools. The survey was based on questionnaire comprising questions related to learning methods, Mathematics learning, examination methods and learning difficulties. Survey results present that they follow Braille system for reading and writing. In case of mathematics, talking calculator is not available in schools. As Taylor frame and abacus are the only options for counting numbers, they face many problems while calculating large numbers and complex calculations. This paper examines and tries to list out the key issues associated with mathematics learning and proposed some solution to improve the current learning process for blind students.*

Keywords: Mathematics Education, Blind, Braille

INTRODUCTION

Approximately 10 percent of the world's population (650 million) lives with a disability and they are the world's largest minority (UN, 2013). A large portion of the disable people is visually impaired (VI). The number of VI in the world is nearly 285 million (WHO, 2013). Among them, around 39 million people are blind and rests of them are suffering from low vision. The developing world contains the largest portion of this VI population, which is 90% (WHO, 2013). Moreover, approximately 19 million children are visually impaired among the below 15 age group (WHO, 2013). According to UNESCO, in developing countries 90% of disable children do not get the opportunity to attend school (UN, 2013). Additionally, insufficient number of Special School and lack of suitable technological tools are the two major challenges faced by this developing world's VI children.

Bangladesh is a low-income country and nearly 19.6% people are physically challenged in this country with at least one disability (Mitra et al. 2011). The number of VI in Bangladesh is approximately 750,000 (Rahman 2012). Bangladesh has 341,819 VI children in the 6-11 age group, which is about 19.7% of all disabled children in this age group (Das 2011). Bangladesh also struggles with rampant illiteracy along with a lot of people with different types of physical disabilities. The literacy rate is 57.7% (62% for males and 53.4% for females), which demands for ensuring education for all, including those with disabilities (EFA 2010; The World Factbook 2013).

However, blind students only have to depend on their touch and haring to get education. There is a universal method that is

followed in visually impaired people's academia that is called Braille. From the invention of Braille till now, so many Braille based technological tools and methods have been introduces all over the world. However, VIS face many difficulties in studying mathematics specially while calculating the numbers manually as they cannot use calculators like the sighted children. Talking calculator and advanced technological devices are available nowadays in many countries of the world to assist VIS in learning mathematics and science. Bangladesh could not provide mathematics and science related education in tertiary level due to the lack of such assistive technologies for learning mathematics and science. However, VIS have to study mathematics in primary and secondary education and they face many difficulties while studying the subject. In order to know and understand the current scenario in mathematics education in primary and secondary schools for blinds, a survey is conducted. This paper presents the survey results as well as proposes some recommendations to elevate the current condition. The article also discuss about the basis of mathematics learning by the blind students and educational system for them in Bangladesh.

Education for VIS in Bangladesh

In Bangladesh, the Ministry of Social Welfare (MOSW) and Ministry of Education are working together to ensure education to the students with special needs (Hossain, 2008). Three types of education systems for the children with special needs are available in Bangladesh; namely special, integrated and inclusive education systems (Hossain, 2008). Several other educational programs include home-based and distance educational programs are also available along with these types.

Special schools provide education only to students with learning difficulties and physical disabilities. These schools are situated in the 5 major divisional cities of the country. These special schools provide students an education in the Braille system. Approximately 240 students are studying in these schools. The MOSW is presently working to develop these schools and upgrade those to high school level (Hossain, 2008; Hossain, 2005).

Integrated Schools has been started in 1974 to provide education for VI children along with sighted children (Hossain, 2008). The program was established by the Department of Social Services (DSS). 47 units were established at the beginning; however, currently 64 are running in selected secondary schools in 64 districts. VI students are taught using Braille system in these schools.

Inclusive schools were established to accommodate students with any type of disability. In inclusion schools, every student is treated equally regardless of their ethnic and cultural backgrounds, abilities, gender, age, religion, beliefs and behavior (Alam, 2005; Malak, 2013). The government has started to implement inclusive education in primary level of education from 2003. However, the progress of this program is not satisfactory due to the lack of necessary content related to disabilities; lack of skilled and trained teachers, etc (Das & Ochiai, 2012).

MATHMATICS EDUCATION

Before describing the problem in this project, it is necessary to clarify a certain amount of background information regarding mathematics and science and access to the materials for blind people.

Unified English Braille for Math

Unified English Braille (UEB) is a Braille code developed by the International Council on English Braille (ICEB) to bring together several existing Braille codes into one unified code. This includes the literary code, mathematics code and computer code. UEB has been adopted in most of the major English speaking countries. Table 1 shows Braille dots for the numbers. To write the Braille numbers VI need to put the numeric indicator {3456} and then write the numbers as the indicator always stay before numbers (Harland 2014). Math symbols are consist of two cells and one cell in the math symbol indicator. The dots combination for this math symbols are shown in Figure 1. Figure 2 represents some examples of the equations.

Table 1 - Braille dots for Numbers

Numbers	Dots Combination		Numbers	Dots Combination	
1	(3456, 1)		6	(3456, 124)	
2	(3456,12)		7	(3456, 1245)	

3	(3456,14)		8	(3456, 125)	
4	(3456,145)		9	(3456, 24)	
5	(3456,15)		0	(3456, 245)	
Example	359		Example	1.25	

Figure 1 - Math symbols

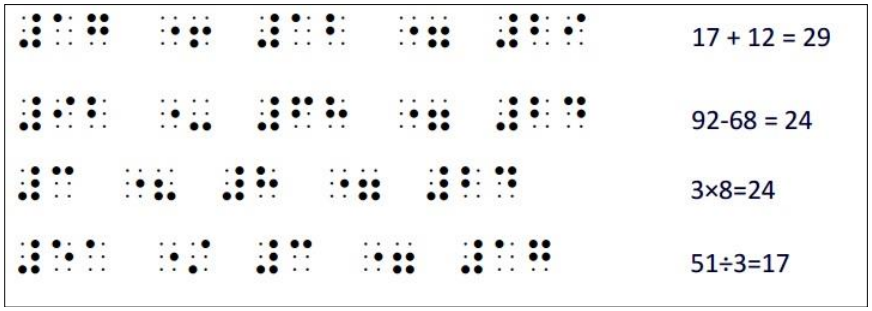


Figure 2 - Examples of equations

2.3 Nemeth Braille for Mathematics and Science Notation

Recent Braille code for Mathematics and science notation is developed by Dr. Abraham Nemeth that uses lower cell numbers**.** Braille readers use the Nemeth code when they are in math class. In the literary Braille code, the numbers are written by putting a number sign in front of the first 10 letters of the alphabet. In Nemeth code, the numbers are "dropped" to the bottom part of the Braille cell, thus no need to put a number sign. This way a Braille reader would not confuse the letter "a" Dot 1 with the literary Braille number "1" #a . Following Figure 3 shows a comparison between UEB & Nemeth Braille codes. It can be easily understood from the Figure that Nemeth Braille code is much easier than UEB code.

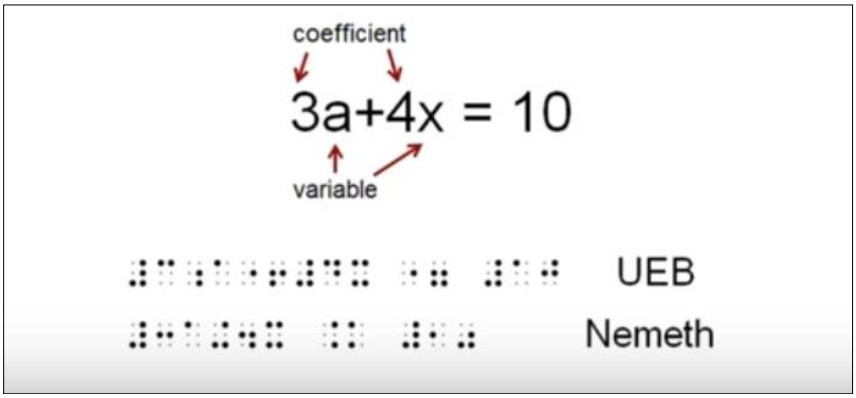


Figure 3 - Comparison between UEB & Nemeth Braille codes

There are a lot of rules about how to write Nemeth code. Students not only have to learn how to do the math, but they have to learn the rules for reading and writing it in Braille too (Denault, 2010).

NEEDS ASSESSMENTS SURVEY

To analyze the present scenario, four blind schools in Bangladesh were visited to identify the challenges that blind students face, their needs and expectations. The survey was done through questionnaires with eight teachers (5 blind and 3 sighted) who are teaching the blind students in the schools. During this survey the questions were read one by one to the respondents and answers were recorded as some of them were blind. Summary of the questionnaires are given below in Figure 4.

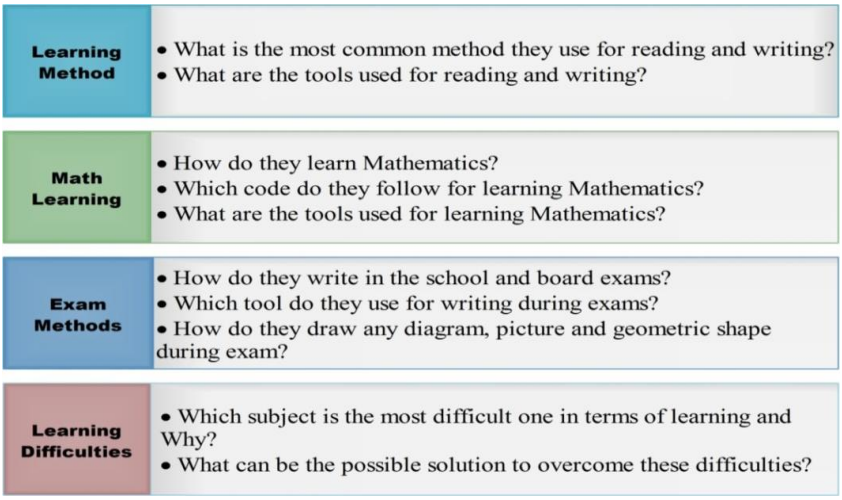


Figure 4 - Summary of survey questionnaire

All the questions of the questionnaire are arraigned in such a way that it can be able to find out all basic information of the four criteria including learning method, math learning, exam methods and learning difficulties. Teachers responded that the traditional slate and stylus remain the only option for students to learn Braille. Additionally, beginners learn numbers and counting by using Taylor Mathematical Slate and till secondary school the use Abacus for counting (Table 2). Due to the unavailable resource they are deprived of science education in Bangladesh. In college and university level they only study those subjects that they can memorize. However, the teachers added that blind students are very curious to know about science subjects. Summary of the response by the participants are given below in Table 2.

Table 2 - Summary of results from questionnaire survey

Schools	Learning Method	Math Learning	Exam Methods	Learning Difficulties
Special 1	•Braille •Slate & stylus	•Using Taylor frame •UEB •Taylor frame & Abacus	•School exam- Slate& stylus; Board exam- writer •School exam- Slate & stylus •They cannot draw; just don't answer the questions	•Mathematics, because no calculator or any other technological tools •Talking Calculator or any other tools
Special 2	•Braille •Slate & stylus	•Using Taylor frame •UEB •Taylor frame & Abacus	•School exam- Slate& stylus; Board exam- writer •School exam- Slate & stylus •Cannot draw	•Mathematics, as counting is difficult without technological tools •Talking Calculator or other technological devise
Integrated	•Braille	•Using	•School exam- Slate &	•Mathematics, because

	•Slate & stylus	Taylor frame •UEB •Taylor frame & Abacus	stylus; Board exam-writer •School exam- Slate & stylus •Cannot answer the question as cannot draw	no technological tools and lack of efficient and trained teachers •Special Calculators or any technological tools
Inclusive	•Braille •Slate & stylus	•Using Taylor frame •UEB •Taylor frame & Abacus	•School exam- Slate & stylus; Board exam-writer •School exam- Slate & stylus •They cannot draw and don't answer the questions	•Science especially Math, because no calculator or other technological tools for science learning. •Talking Calculator or any other three dimensional models.

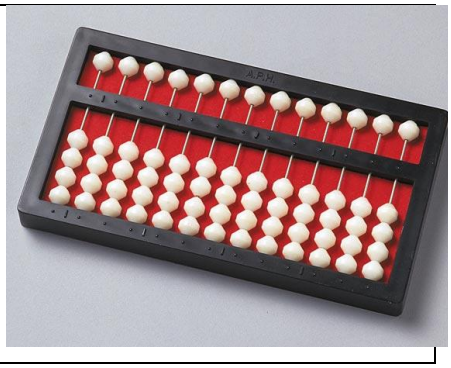
Table 2 shows that all most all the schools follow same methods and tools to teach blind children. One very important finding from this survey is that though the blind students participate/ write in the schools exams using slate and stylus, during the board exams they have take the help of a writer who will listen the answer from the blind student and will write it on behalf of the blind student. Usually this writer has been chosen by the school and this writer will be one or two academic year junior then the blind student. Actually, the examiners are same for all blind and sighted students, therefore if the blind students write the exam paper in Braille than the examiners who are not from blind schools will not be able to understand it.

Respondents mentioned that the most difficult subjects mathematics as the in the higher level it requires to square, roots, geometry etc... They also added as there is no calculator available they face difficulties in complex calculations. As they face difficulties in complex calculation, they can't even think about scientific calculations. As a result they are bound to take Arts education/non-science as their major in 9th class. However, until class 10 all the students have a compulsory subject general mathematics and there they have a so many complex calculations but as they don't have calculators they have to skip the questions. They emphasized that blind students do not have the opportunity to have the science education both in secondary and tertiary education. Although many students eager to study science but they are compelled to take Arts or Humanities. They stated that most of the visually impaired students wish to have a technological solution that will provide the opportunity to math more easily.

The mathematics learning tools that are used in Bangladesh is described in Table 3.

Table 3 - Mathematics learning tools used in Bangladesh

Tools	**Figures with appropriate code**
Taylor Mathematical Slate: In mid 19th century Rev. William Taylor developed this device to teach mathematics to blind students. The Taylor Mathematical Slate consisted of an aluminium frame and a set of metal pegs or type with the patterns. The frame has rows of opening each set out as an eight pointed star. The pegs could therefore be placed in the frame in one of eight orientations which could be used to represent numbers, letters or signs. Math can be composed in linear, vertical or in algebraic notation.	 **algebraic notation** $$ (2x + 3)(x^2 − x − 5) $$

Abacus: It is a device used by visually impaired children for doing basic mathematical calculations. Abacus is rectangular in shape. Abacuses with varied columns are used in different countries. This instructional material is written specifically for the abacus with 15 columns. The common operations for this abacus are same with those of the abacuses with fewer columns, but the number of columns matters especially when fraction problems are solved.	

RECOMMENDATION

The survey results show that blind students face a lot of challenges and difficulties in studying mathematics in classroom as well as during board examinations. Therefore, following recommendations are proposed to elevate the current situation.

Separate Education Board or unit: During the needs assessment survey; a significant findings was that the blind students were very frustrated and disappointed as they could not write their board exams paper in Braille because the examiners are same for all the sighted and blind students. Therefore, they have to take another sighted person's assistance, who writes on behalf of them. Govt. of Bangladesh should make a separate educational board for the blind students as their writing method is different. If is not possible to have different education board, then under every board Govt. could make special unit for blind students. In this special unit all the examiner will be selected from blind schools or any schools where blind students study. Figure 5 shows the strategy implementation model for separate exam unit for blind students.

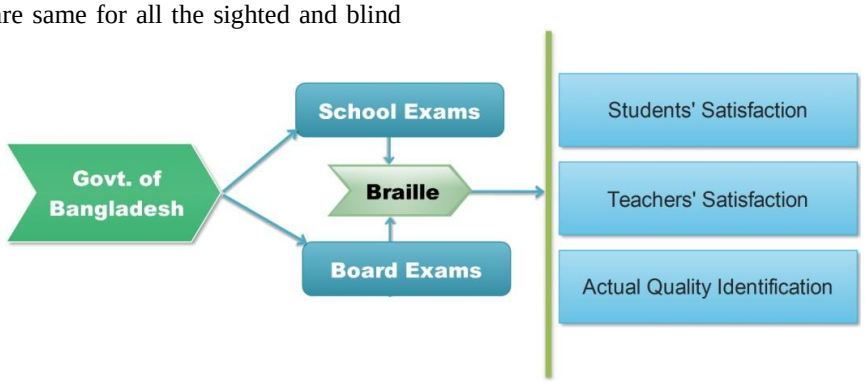


Figure 5 - Strategy implementation model

Implementing Nemeth code:

As Nemeth code is much simplified and easier than UEB code, all school should implement this code with the help of Government. Nemeth code will make the mathematics learning easy and interesting to the blind students and government should take the initiative to introduce this code. If the government introduces Nemeth code then these students will not be deprived of science education also as it has all Braille science notations.

Talking calculator:

The most difficult task for the visually impaired students is to calculate numbers, as they cannot see they cannot use calculators. Most of the cases they face problems in the large calculations. VIS face more problems than sighted students because they need to calculate manually. Moreover, in case of the double and multiple digit numbers they face many difficulties in calculations. Therefore, a mobile application called "BTbrailleCal" is proposed which will assist the blind student in calculating numbers. In addition, the application will not require a person's assistance because the audio instruction will guide VIS. The application will take input in Braille dots as the students learn on the school and will provide voice feedback while they give any input and finally the result of the equation. For usability, the buttons will be large and the positions of the buttons can be easily distinguished if a user maintains his or her fingers at the edge of the mobile phone. Moreover, the detailed instructions of each screen, which are relayed through voice and vibration feedback for each button, will guide users. All instructions will be in Bangla. All the interfaces are shown in Figure 6.

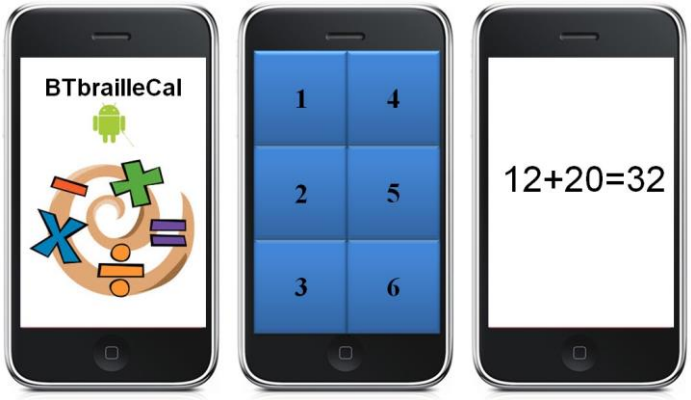


Figure 6 - Interfaces of the application

Figure 6 represents opening screen, Braille input screen and the result screen of the proposed application. Detail instructions regarding how the application will work, will be provide with the arrival of the opening screen of BTbrailleCal. Then the Braille input screen will come and ask the user to input the numbers they want to calculate. This calculator will take the input in the same way they write the math equation. When the user will give input the symbol "=", automatically the result screen will arrive and will read the equation and result for the VIS users.

CONCLUSIONS

As the education process is more complicated for the blind students compared to the sighted students, Bangladesh government needs to give special attention to this. If government could not provide suitable opportunities to educate these huge numbers of blind students, then they will become a burden to their family, society and the country as a whole. Therefore, a strategically strong infrastructure needs to be developed. As a part of this infrastructure, the government could improve the curriculum for mathematics so that these blind students can compete with other blind students internationally. For example, Bangladesh can try to adapt Nemeth code like the developed part of the world. Additionally, government should take the initiatives to make separate unit for the board exams for blind students, so that they can show their actual capabilities.

On the other hand, though several ICT tools are available for reading, such as DAISY, a few tools are available for writing. Additionally, Math learning devices are costly. Due to the crisis of the availability of low-cost Mathematics learning technological tools, a high demand is present for a tool that will help VIS to calculate number more easily. Additionally, if these calculating facilities can be provided through an existing device like smart phone that most of people already have, it will be really helpful for the students. Therefore, if the proposed design of BTbrailleCal can be materialize, then it will be a great resource for the blind students in Bangladesh.

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