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Analysis of training and visualization of proposed mathematical symbols for blind students

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Abstract

The present life has become challenging. In this highly competitive world, it has become very difficult for normal people to compete. If normal people are to struggle in extreme, then it's really difficult to imagine what complications the visually impaired face. The hardships and struggles faced by the visually impaired are in learning mathematics. In this study, effort is made to lessen the challenges faced by the students to learn advance level of mathematics. In this research, the focus is given to the mathematical symbols which have been categorized based on the functionality. An effort is made to present the symbol in a shape very close to the actual shape of the symbol. This will align the conceptual and advance learning without any variation for the blind students. To make this research effective, the research was implemented in two blind schools, one in Punjab and one in Chandigarh. A new framework is designed for training purposes based on the system followed in both blind schools. Training was imparted in both the schools and analysis was done on the outcome to show how much the new framework will be effective for the visually impaired students. To comprehend the effectiveness of the research, analysis was done on blind students, the teachers, and the parents.

Subject Classification: *68T50.*

Keywords: *Braille, New mapped mathematical symbols, Feasible analysis, Training methodology.*

1. Introduction

Normal students think of progressing in life day to day and try to clear out all the hurdles that come on their way to success, but the case is

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not the same with the students who are unable to see. They have to face problems at each and every step of life due to their inability and their condition makes learning challenging for them and becomes motivating factors for research scholars to work in that direction to resolve their issues. The author's journey started on the day when she met these challenged students face to face and interacted with them and observed minutely the blind students way of studying, their way of understanding, the concept, and their way of resolving problems. It is really a great job in itself to teach such students. Even there are different methods to teach juniors and seniors. The biggest challenge to teach them is to keep them motivated and in high spirits. When their problems in the way of studying were observed deeply, then it was found that they were mainly facing the problem in the study of mathematics [1-4]. Let's take for instance, they might be theoretically updated that square has four sides. However, the mystery of its visual pattern is visually not relatable in their mind until some valid prepositions were made of existence into their mind with repetitive sentences. However, we have come to a conclusion to utilize the blueprint of Braille as well as Nemeth codification rules [5, 6]. Yet, even simple concepts often taken for granted will pose difficulties for a blind student as he or she pursues more advanced research. Techniques that promote the ability of students to mentally measure and remember mathematical data, and to use methods to keep track of partial sums and products, may be of great help in this regard, although they may not eradicate the issue. Unconventional symbols like theta, alpha, beta, and gamma are distinct however, majority of them are unable to register in their minds [7]. Apart from that, square being 4 side polygons can't be the same way registered in minds. Even problems of remembering long equations and BODMAS expression from where it needs traversing, still add another kind of genuine ambiguity [8-12]. Students who have difficulty or limited quantitative learning are of particular interest when considering mathematics teaching and learning strategies [13-15]. First of all, the following contribution focuses on the issue of labeling the group of students with mathematical subject difficulties, especially in learning mathematical symbols used in algebraic equations and trigonometry since there is no single definition [16-18]. This problem can be traced to the different origins of mathematics teaching on the one hand and special education on the other. In the second experiment, it was attempted to reproduce those findings, concentrating on simpler mathematics. Everything is created in mathematics; no one can create anything new like music and art. On the other hand, teaching methods in mathematics can

be innovative so that students learn may better. With regard to the dimensions of imagination, the study of the responses given to the pre-test and post-test indicated that all students were increasing in terms of fluency, they offered more and more different ways of seeing–taking advantage of the path of reading, symmetry, and various geometric arrangements. All the same, challenges stand in the path of secondary school students, but teachers focus much more on electronic educational resources that are not typically equipped for blind students. This suggests that blind students may have difficulty accessing information when learning on their own and coping with some online homework assignments and may misinterpret the facts [19, 20]. Teaching in secondary school is at a faster pace and more complex. Therefore blind students may find it more difficult to learn. Creating a new way of teaching is not only the challenge to implement the same. Teaching online to students during COVID-19 was also a challenging task for teachers [21]. In the future, machine learning could greatly enhance online teaching [22-27]. It was not possible for the author to cover all the problems but she targeted particularly mathematical symbols which blind students are taught at the beginning level, then thread, button, and hard objects are used to teach them by the method of identification and in later stages these teaching methods are replaced by Braille language that is code based. Blind students face problem at first stage they learn through hard objects and then through code language, which has no resemblance with the shapes taught using hard objects. These methods make the learning of mathematical concepts very difficult and slow. The major focus of the authors is to align the learning of mathematical symbols using hard objects with the braille code. The authors have categorized mathematical symbols and changed the shape of mathematical symbols in braille language. No doubt, a new system may seem easy to bring but it is really hard to train them in the same but the effectiveness of the framework was measured along with new mathematical categorization by implementing it in two blind schools.

2. Principal Outcomes And Significance

a. Blind students grasp basic mathematics through touch, but a shift to code-based teaching in advanced classes confuses and deters them from pursuing mathematics.

b. Several factors affecting blind students include parental support, teaching resources, and the student's ability to handle pressure leading to challenges in their education.
c. Earlier mathematical symbols were taught through touch in the beginning and later we employed similar shape codes to clarify their understanding.
d. Finally, a training was conducted training at the blind schools to validate the newly created codes for mathematical symbols, assessing their impact on the blind students.

3. Feasible Analysis Of Adopting And Executing New Mapped Mathematical Symbols

Every research work contributes to the social development. This is feasible only if it fulfills the practical implementation. If it is successful, then only it is able to reduce the various challenges for the targeted segment.

A. *Analysis of the Teaching Criteria*

The primary and main challenge of the research is to familiarize oneself with the teaching techniques used to teach the visually impaired. It's important to understand the criteria to be opted to make mathematical symbols understanding convenient for them. This will help them to understand and follow the mathematical symbols in a much easier way.

B. *Analysis of the Learning Capability of Students*

Another next challenge was to understand the learning capability of the visually impaired. No doubt, the new mathematical symbols that are being tried to be executed among the visually impaired are highly useful but it's important to observe the ease of understanding and adoption among the visually impaired.

C. *Analysis of Time in Understanding the Concept*

If research fits into controlled time parameters, then the research is considered successful. The students are able to understand the mathematical symbols but take too much time to understand, then the research is said to be less effective. In this situation, the research is

considered useless Therefore, the time taken by the visually impaired to understand the mathematical symbols were analyzed.

D. *Analysis of Audio Tools*

As blind students are not able to see, it was further important to confirm if they are able to identify the new mapped code by listening. This confirmed the feasibility of audio aid in teaching them the new mapped code for the mathematical symbols.

E. *Analysis of Finger Touch*

The blind students are able to read with the touch sense. This main parameter of touch was considered of high significance while conducting the research. After analysis, the success rate has been calculated as shown in Figure 1.

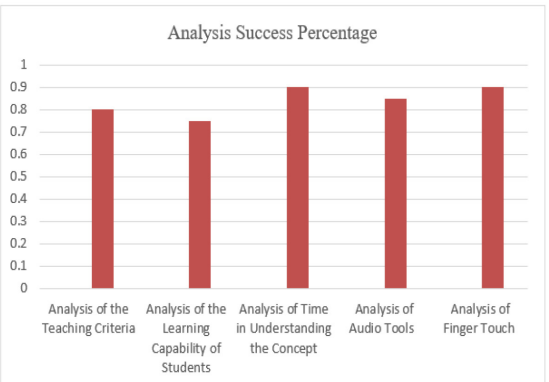

Figure 1

Feasibility Analysis Success Rate

After using all the parameters, the feasibility of the research has been confirmed and after that, the training of new mathematical symbols framework has been designed.

4. Implementation Of New Mapped Mathematics Symbol Model Training Methodology

Teaching blind students something new is a very challenging task. It's difficult both for the trainers as well as the blind students. Various surveys were conducted in many educational organizations and finally, two schools were shortlisted for the study and research. The first school

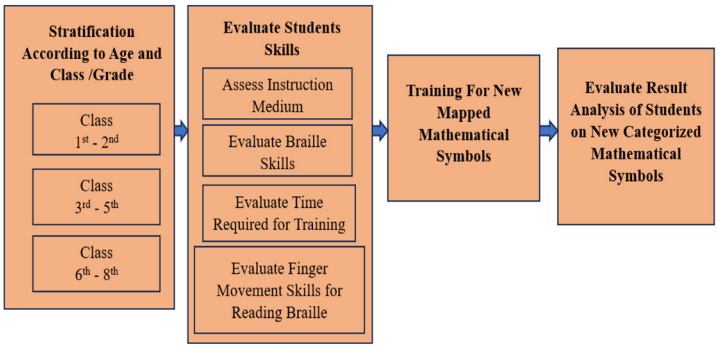

Figure 2

Training Framework Methodology for Visualization of New Mathematical Symbols

was the Deaf, Dumb and Blind school in the village Saidpur, District Patiala, state Punjab, and the other school was the Blind School, Chandigarh. For blind students, only the touch method works. For touch, the students only know the Braille Language. Letters of the alphabet, numbers, and punctuation marks are represented in braille using a dot configuration. The braille grid, also known as the basic braille symbol, is made up of six dots set three high and two wide to form a rectangle. Some of these six dots turn into other symbols. A training framework methodology has been designed to finalize the framework for delivering the training as shown in Figure 2.

A. *Stratification according to Age and Class /Grade*

Imparting training to blind students was a challenging task because of the different age groups. Therefore, the students were divided into

Table 1

Blind Students Categorized According to Class Group for Training

Schools	Number of Blind Students							
	1st Class	2nd Class	3rd Class	4th Class	5th Class	6th Class	7th Class	8th Class
The deaf, dump & blind School (Patiala)	18	7	4	12	11	8	8	5
Blind School (Chandigarh)	13	13	11	12	13	16	15	15
Total	31	20	15	24	24	24	23	20

three categories as per their present class or grades as per Table 1. Different methods were adopted to train all the three groups.

B. *Evaluate Students Skills*

Before imparting the training to blind schools, it was important to analyze the student's skill set so that the research may prove beneficial to them in their future life. In order to evaluate the student's skill, four parameters were considered as below:

a. Assessment of Medium of Instruction

Initially, it was important to observe the medium of instruction students were comfortable with. It was observed that the medium of instruction varied among schools and among students too. Table 2. Represents the data collected during survey for the same purpose. From the survey, it was concluded that the Patiala student's priority was Punjabi and then Hindi, whereas the students of Chandigarh gave priority to English and then Hindi. Therefore, finally three languages were finally opted for teaching them verbally i.e. English, Hindi and Punjabi.

Table 2

Survey of Instruction Medium for Teaching to Blind Students

Instruction Medium of Blind students	Number of Students							
	1st Class	2nd Class	3rd Class	4th Class	5th Class	6th Class	7th Class	8th Class
Hindi	16	14	6	4	11	8	12	5
Punjabi	10	3	3	10	6	8	5	2
English	5	3	6	10	7	8	6	13

b. Evaluate Braille Skills

It is understood that the blind students study with Braille. The understanding of Braille is of utmost importance to them. It's evident that the Braille language can be understood with finger touch. If a student is not able to touch properly, he may fail to understand that. There may be various reasons for failure in touch like nervousness, and shivering due to poor health. Therefore, to serve this purpose, the proficiency level was analyzed in a survey which is reflected in Table 3.

Table 3

Class wise Braille Skills of Students

Class	Braille Skills		
	Good	Average	Below Average
1st-2nd	25	15	11
3rd-5th	32	30	5
6th-8th	35	25	17

c. Evaluate Time Required for Training

When the survey was conducted as per Table 4, it was observed that not all students were at equal level. Much difference was observed. Many were intelligent and followed the instructions easily, in less time. On the contrary, there were students who took much time to follow. There were students who took twice the time of a few students as reflected in Table 4.

Table 4

Evaluation of Training Time Required for New Mapped Mathematical Symbol

Class	Training Time (In Days)
1st-2nd	16
3rd-5th	11
6th-8th	8

d. Evaluate Finger Movement Skills for Reading Braille

Blind students learn by Braille. For Braille, the finger movements play a significant role. The speed of finger movement is very important too. It was observed during the study that the speed of finger movements varied among students which is depicted in Table 5.

Table 5

Finger Movement Speed

Class	Braille Skills		
	Good	Average	Below Average
1st-2nd	27	13	11
3rd-5th	33	27	7
6th-8th	50	25	12

C. *Training*

It was observed while imparting the training that the students were curious to learn something new, but on the other hand, a few teachers' reluctance could be observed. Furthermore, the parents' willingness was appreciated. It was important to train the students to understand various limitations among the students that hinder their learning process. Considering all the above parameters, the training was emphasized to get the desired results of the research as shown in Table 6. Various techniques were adopted and implemented to confirm the understanding in the below subsections.

Table 6

Physical Object Analysis of Blind Students

Reading Skills Mode	Number of Students							
	1st Class	2nd Class	3rd Class	4th Class	5th Class	6th Class	7th Class	8th Class
Thermocol	14	16	4	6	11	2	15	8
Audio	3	10	3	10	6	8	5	2
Braille Sheets	3	5	6	10	7	8	6	13

D. *Result Analysis*

At the end of the training, it was found that it proved quite fruitful as it met completely the required parameters. Moreover, blind students were able to get trained successfully in the newly mapped code mathematical symbols. The success of training indicated and proved that the newly mapped mathematical symbols can play a significant role in the studying of mathematics, mainly the points considered at the stage of training were to observe how much stress the students felt when they were taking training. The next point was to consider if their fingers moved comfortably to adopt the designed symbols and it was a great relief to notice that they were quite comfortable. To learn the new mapped braille mathematical symbols, students must be free from fear of learning new techniques. It was quite satisfactory to find that in the beginning, they were little fearful but were quite comfortable later. Adopting those new symbols was the next challenge during the process of training. Students' responses during the training proved that they adopted them very well. It was also necessary to find that the students were adopting them in an accurate way. After doing the overall analysis, the result was divided into three categories

students, teachers, and parents. The study was based on various parameters like time, stress, accuracy, and willingness. Each and every category is associated with each other and is indispensable. The outcome was appreciable and welcomed by all the categories responses during the training. For considering the parameters ranking values have been given to each parameter as shown in Table 7.

Table 7

Ranking Parameters Set to Evaluate Effectiveness

Parameters	Excellent	Good	Average	Below Average	Worst
Time	5	4	3	2	1
Stress	5	4	3	2	1
Accuracy	5	4	3	2	1
Willingness	5	4	3	2	1

Results have been shown in Table 8. based on the performance of blind students.

Table 8

Class Wise Training Impact Analysis With Respect to Blind Students

Parameters	Blind Students							
	1st Class	2nd Class	3rd Class	4th Class	5th Class	6th Class	7th Class	8th Class
Time	3	3	4	4	4	5	4	5
Stress	4	4	5	3	5	5	4	4
Accuracy	4	4	4	3	4	4	4	5
Willingness	3	3	4	3	4	5	4	5
Average Effectiveness	0.7	0.7	0.9	0.6	0.8	0.9	0.8	0.9

Results have been shown in Table 9. based on the teachers performance.

Table 9

Class Wise Training Impact Analysis With Respect to Teachers

Parameters	Teachers							
	1st Class	2nd Class	3rd Class	4th Class	5th Class	6th Class	7th Class	8th Class
Time	5	5	4	4	4	5	4	5

Contd...

Stress	4	3	4	3	3	4	5	5
Accuracy	3	3	4	4	4	5	4	4
Willingness	5	3	4	3	4	5	4	4
Average Effectiveness	0.8	0.7	0.8	0.7	0.7	0.9	0.8	0.9

Results are shown in Table 10. based on the performance of the parents of the blind students.

Table 10

Class Wise Training Impact Analysis With Respect to Parents

Parameters	Parents							
	1st Class	2nd Class	3rd Class	4th Class	5th Class	6th Class	7th Class	8th Class
Time	3	4	4	4	4	5	4	5
Stress	3	3	4	3	5	4	4	4
Accuracy	4	5	4	4	4	5	5	5
Willingness	5	4	4	3	4	5	4	5
Average Effectiveness	0.7	0.8	0.8	0.7	0.8	0.9	0.8	0.9

After analysis, it has been found that all the parameters reflect that there is fluctuation in the performance of the students who belong to class 1st to 4th but performance is found quite satisfactory in the students from 5th and 8th, as they are already well versed in braille and quite ready to adapt new mathematical symbols.

5. Conclusion

At the last stage of this entire training, the contribution of this research to reach mathematics with the help of a new mapped braille mathematical symbol was quite evident. Each and every point was considered minutely which could have made this research quite useful. Feedback from the trainers was that this alignment of braille symbols with real mathematical symbols has created a good impact on the learning capabilities of the trainers. Also, the training time of the learning process has been reduced significantly. Generally, the students lose interest in mathematics when they feel significant difference in learning actual symbols through shapes and the braille code symbols. In this framework, since the new mathematical symbols are aligned with the shapes effectively, they could maintain the interest to continue mathematics as a subject in higher studies. It was

really satisfactory to find that training proved quite successful. It is a new ray of hope for the blind students who were quite confused with the previous braille code. It is expected that humble contributions would motivate more blind students to take an interest in mathematics. The support of teachers and parents was also welcoming. The willingness and excitement among the students to pursue mathematics in the future shows the effectiveness of the study.

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