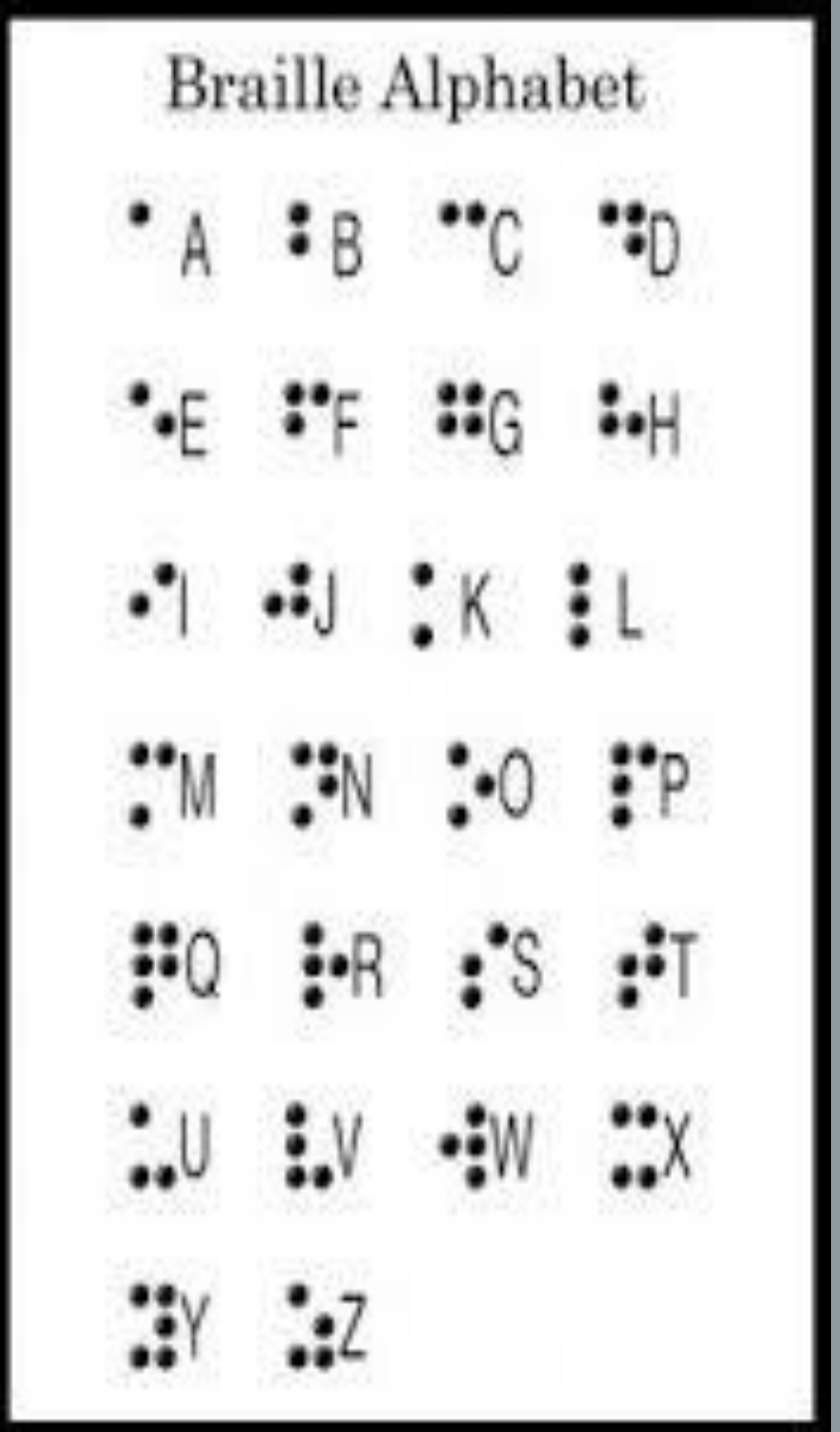


The Impact of Braille Systems on Advanced Mathematical Geometry

Presenter:

OGBOLU MELVIN OMONE

OVERVIEW

- The invention of certain systems/tools for text transcription for people who are visually impaired or blind stands as a surge in technology and helps the people become independent, learned, and skillful. In the past decades, several systems/tools have evolved.

- In this paper, the Braille system, the types of Braille, and tools which are applicable and most suitable with the Braille system for teaching mathematical geometry are explored.

Table 1: The Existing Braille Systems; Characteristics, Limitations and Strengths

Nemeth Braille	LAMBDA Braille	Marburg Braille	UEB	French Braille
Designed in 1946 by Abraham Nemeth.	Designed during a 3 years European project, whereby 15 people from 8 different countries were involved.	Designed in 1955 by Helmut Epheser, Karl Britz, and F. Mittelsten Scheid.	Designed in 1970 by a group of blind people led by Thomas Rhodes Armitage.	Adapted to mathematics in 1922 by Louis-Auguste Antoine.
Mathematical Expression Level				
Expressing technical/advanced and simple aspects of mathematics.	Expressing linear equations and has a software known as LAMBDA editor which is derived from MathML. It is also an XML-based code, but graphical view is in MathML.	Expresses literal mathematical contents in a static and dynamic approach.	Expresses all contents of mathematics. Though certain complex expressions remain or become more complex after transcription.	It is the basis of all other Braille systems. Expresses all contents of mathematics and literal contents.

Nemeth Braille	LAMBDA Braille	Marburg Braille	UEB	French Braille
Effectiveness; representing mathematical notations and science expressions in Braille.	Effectiveness; audio representation, reading, writing, creation, exploration, and exploitation of manipulation operations of teaching material for the blind, visually impaired and visually unimpaired.	Effectiveness; enhances accessibility to mathematical contents and used in writing descriptions on used on pharmaceutical packages.	Effectiveness; with the use of modifiers, mathematical expressions, special symbols, numbers/digits are transcribed and simplified.	Effectiveness; teaching and expression of mathematics for the blind, visually impaired and visually unimpaired.
Shape Expression Level				
Symbols are introduced to replace mathematical functions for a better transcription.	Not applicable.	Not applicable.	Symbols are introduced to replace mathematical functions for a better transcription (like Nemeth).	Limited literature.
Function Expression Level				
Symbols are introduced to replace mathematical functions for a better transcription.	Symbols are verbalized and visualized in the form of a descriptive language.	Not applicable.	Symbols are introduced to replace mathematical functions for a better transcription (like Nemeth).	Limited literature.

Nemeth Braille	LAMBDA Braille	Marburg Braille	UEB	French Braille
Formula transcriptions have the least number of characters as compared to other types of Braille for easy assimilation. It also adds assistive spacing before and after equals sign (=).	Formulas are represented in a form of a linear code visually.	Not applicable.	Formula transcriptions have a greater number of characters as compared to the Nemeth Braille code.	Limited literature.
Equation Expression Level				
Equations which contains fractions are indicated with the use of special characters.	The compactness and universality of equations being transcribed helps to facilitate learning and comprehension.	Not applicable.	The application of the prefix-root principle helps to eliminated unambiguity for equation transcriptions.	Limited literature.
Function Analysis Accuracy				
With it 6-dot Braille code combinations, its translator supports the conversion of functions, expressions, formulas, and equations written in Latex formats.	With it 8-dot Braille code combinations, it can automatically convert linear equations into formats of MathML (i.e. Latex and MathType).	Not applicable. Thus, it doesn't have a standard for dot combinations, but the transcribed dots follow a specific font, symbol, and dimension.	With it 6-dot Braille code combinations. It is the combination of 3 Braille system notations, i.e. the literary Braille, the Nemeth Braille code, and the computer Braille notation.	With it 6 to 8-dot Braille code combinations, it is capable of transcribing equations, formulas, functions, and expressions in using French alphabets.

Nemeth Braille	LAMBDA Braille	Marburg Braille	UEB	French Braille
Learning Capability				
The Nemeth Braille code is complex to learn with due to it high number of indicators and existing symbols for transcription.	The LAMBDA Braille code is used worldwide and applicable internationally. It is not limited by region/country. Hence, it is very recognized and versatile in use.	The Marburg Braille code is very easy to learn and transcribe.	UEB is limited in transcribing complex mathematical expressions, functions, equations, formulas, and related computer science notations for adequate comprehension by readers.	The French Braille code can transcribe any subject but limited to blinds/visually impaired who are familiar with French alphabets.
Usage by Country/Region				
Survey shows that users refer Nemeth Braille code for mathematics than UEB due to it assistive properties. Adopted in India, Thailand, Malaysia, Indonesia, Cambodia, Vietnam, Canada, Iran, Israel, Lebanon, New Zealand, Pakistan, Saudi Arabia, Greece, Sri Lanka, United States of America, and Western Samoa.	It is used in many countries, such Italy, Portugal, Greece, France, Russia, Spain, Germany, United Kingdom, etc.	Adopted in Germany, Austria, Poland, and many German speaking countries.	Adopted in United Kingdom, Ireland, Australia, Barhein, Hong-Kong, Iran, Jordan, Kenya, Nigeria, Saudi Arabia, Sierra Leone, New Zealand, Singapore, and Zimbabwe.	Adopted in France, Madagascar, and Portugal.

Mathematical Geometry For The Blind And Visually Impaired People

- The use of visual notations and expressions are both vital and appropriate in teaching mathematical geometry.

- Geometry is a means of representing sizes, shapes, positions, angles, and dimensions of things in mathematics.

Table II: Some Shape Transcriptions with the Nemeth Braille code

S/N	Shapes	Symbol	Nemeth Braille code Transcriptions
1	Circle		
2	Intersecting Lines		
3	Rhombus		
4	Rectangle		
5	Square		
6	Pentagon		
7	Octagon		
8	Trapezoid		
9	Quadrilateral		
10	Parallelogram		
11	Eclipse		
12	Triangle	Inverted Regular 	Inverted  Regular 
13	Concave Arc	Upward Downward	Upward Downward

Table III: Special Signs/Functions and their Transcriptions

S/N	Special Signs/Functions	Symbol	Nemeth Braille code Transcriptions
1	Parentheses	( )	
2	Brackets	[ ]	
3	Braces	{ }	
4	Equal to	=	
5	Not Equal to	≠	
6	Less than	<	
7	Greater than	>	
8	Approximately Equal To	≈	
9	Congruent to	≅	
10	Ratio	:	
11	Multiplication	Cross × / Dot ·	Cross  / Dot 
12	Plus	+	
13	Minus	-	

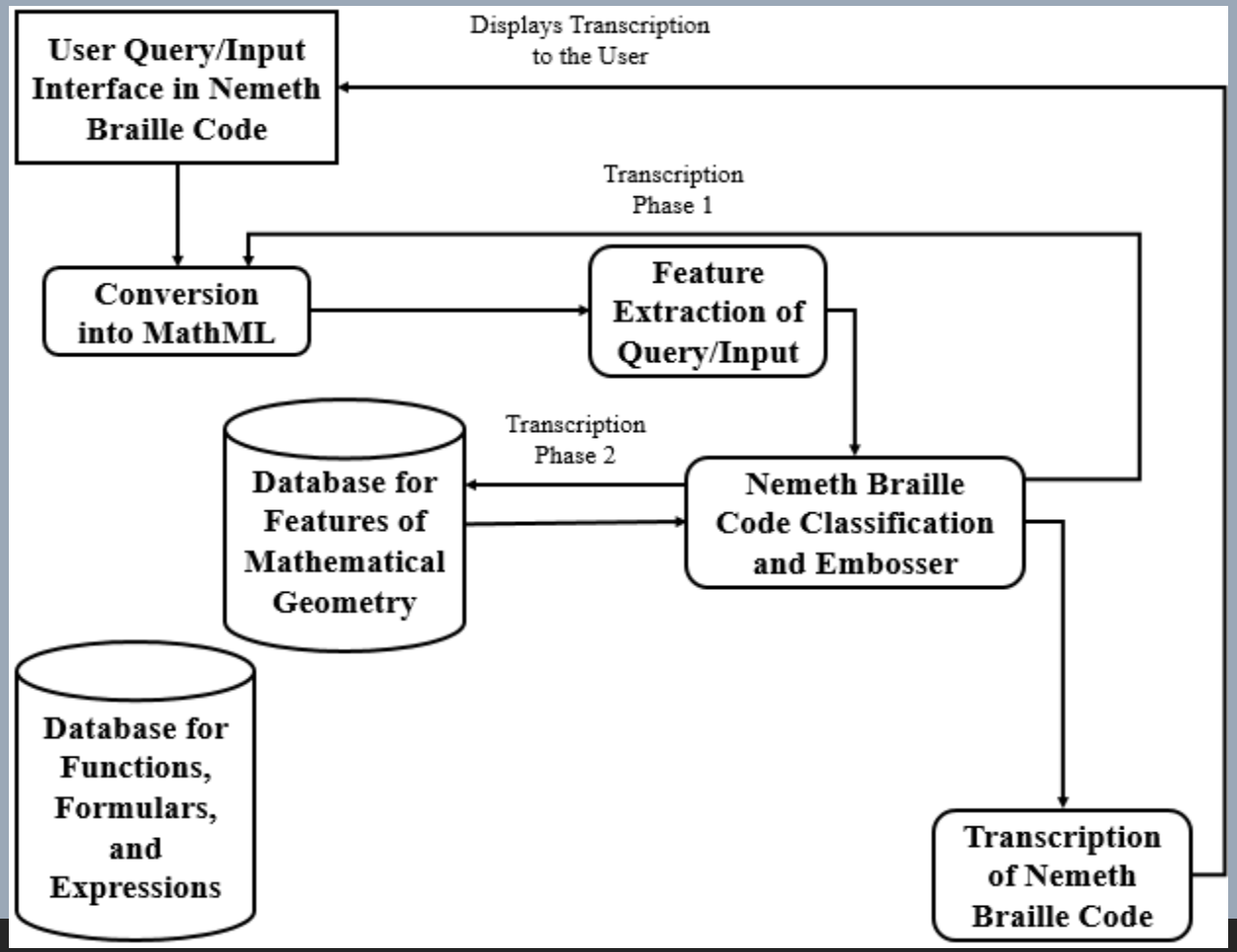
14	Division	÷	
15	Union	∪	
16	Plus or Minus	±	
17	Asterisk	*	
18	Sine (sin)	**sin**	
19	Cosine (cos)	**cos**	
20	Tangent (tan)	**tan**	
21	Determinant (det)	**det**	
22	Amplitude (amp)	**amp**	
23	Exponential (exp)	**exp**	
24	Limit (lim)	***lim***	
25	Maximum (max)	**max**	
26	Minimum (min)	**min**	
27	Logarithm (log)	**log**	

THE NEMETH BRAILLE CODE AND THE USE OF TRANSCRIPTION SOFTWARE OR TOOLS

The use of MathML

- Next to the Nemeth Braille code for teaching mathematical geometry is the MathML software with embedded functionalities of the Braille techniques.
- The MathML is basically known as a low-level specification tool used for describing and displaying mathematical expressions in web pages.

Figure 1. The Structural Transcription of Mathematical Geometry using the Nemeth Braille code



THE NEMETH BRAILLE CODE SOFTWARE FOR MATHEMATICAL GEOMETRY TRANSCRIPTION

- The proposed software for this project shall be developed based on some existing Braille software for text, Latex, and MathML structures; thus, will be tested and implemented.

- The system proposed system is intended to include both the techniques and functionality of the MathML and the Nemeth Braille code to fast track the existing drawbacks faced by the blind and visually impaired and enhance the productivity of mathematical teachers.

CONCLUSION

- This paper presents and explores the types of Braille systems, the systems' efficiency, functional accuracy analysis, reliability, and readability for teaching the blind and visually impaired mathematical geometry.
- The most outstanding system for the purpose of teaching mathematical geometry is the Nemeth Braille code, which includes the transcription of formulas, functions, and equations.
- The use of software for mathematical geometry are efficient and easier for teachers. Thus, the development of a Nemeth Braille code tool which works like the MathML tool is introduced.

Thank You!

Questions?