# Title: Methods for The Blind to Electronically Read and Write Mathematics from Primary School Through College

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# Reading Math

## Status

* Huge progress in the last several years.
* In the past, most web sites used images for math.
* Now MathML is mostly used (often present for screen readers only). Last year when I looked, maybe 80% of sites that had math were accessible. Five years ago, that number might have been 20%.

## How it Works

* MathML – standard for Math on the Web. Part of HTML. Tags like <mfrac>, <msqrt>, <msup>
* Screen readers see those and convert them to speech and braille (Nemeth Code). E.g., msqrt becomes “the square root of …”
  + Special cases for natural speech – e.g. msup with a ‘2’ for the exponent is ‘something squared”.
  + The quality of the reading varies. More on that later

Side note: If you don’t know Nemeth code try to learn it! Every VI teacher I know says the most successful kids are the ones that are proficient in Nemeth code.

## Where it Works

* Reading MathML works in JAWS, NVDA, VoiceOver, ORCA in Web Pages
* JAWS and NVDA will also read math in Microsoft Word (NVDA in PowerPoint also)
  + caveat – must convert to MathType format first
* EPUB/ebooks
  + JAWS/NVDA: Thorium. RedShelf and VitalSource Bookshelf online also work.
  + Mac: Vitalsource Bookshelf both the App & Online version
* Kindle: JAWS and NVDA using the PC App. Note: MathML is much less common in Kindle books.

## Reading differences

* Text: a few differences (Dr. Smith lives on Smith Dr.)
* Math: lots of differences
  + Lots of special cases: mixed fraction -- “one and one half” vs. “one one half”, “line segment A B”, etc.
  + Example that both NVDA and JAWS do mostly right:  Speech example – NVDA , JAWS 
  + Superscript: generally, you will hear “x superscript n end superscript” or maybe “x raised to the nth power”. All will do simple special cases things like “x squared”, but only a few will say “inverse sin” for Speech example -- NVDA: , JAWS 
  + NVDA+MathPlayer is by far the best as it knows many more rules for reading math the way it is read in a classroom. It offers a number of options in terms of ways to reading and verbosity. Also “Speech Rule Engine” with MathJax, but AT doesn’t use it.
  + VoiceOver is probably the weakest in that it only knows a few things like “squared” and “cubed”.
  + The problem with “a”: Speech example -- NVDA , JAWS 
* Navigation
  + For a large equation, reading it all at once can be hard to understand.   
     Speech example – NVDA 
  + NVDA, JAWS, and VoiceOver support navigating an expression; NVDA has the most flexibility.

# Writing Math

### WYSIWYG

* [ChatyInfty](https://www.sciaccess.net/en/ChattyInfty/) – text and math
* Word + MathType (via TeX – more later)
* WIRIS/MathType for the Web – sort of accessible.
  + You hear “blank” then the character as you move around.
  + No way to have the expression read back to you other than moving character-by-character
* [Pearson Accessible Equation Editor](https://accessibility.pearson.com/resources/aee/index.php) – supports both Nemeth input and output. In Beta

### ASCIIMath

* Simple calculator like notation: ()s, /, ^, \_, sqrt
* <=, alpha, oo (infinity), sub(subset), …

### TeX

* TeX is for writing documents, but designed for math-oriented documents.
* LaTeX an extension (set of commands) of TeX.
* Basics of TeX Math
  + Names: \alpha, \leq, \int
  + Grouping: {}
  + Notations: \frac, \sqrt, ^, \_
* Only way to know if you got it right is to listen to it
* If you use Word, get MathType (which isn’t accessible as a WYSIWYG editor). You can type TeX, convert it to regular notation with alt+\, listen to it, and convert it back to TeX with alt+\ to fix it if it isn’t right

### Markdown

* A simple markup language using plain text
  + # heading 1, ## heading 2, …
  + \* list,
  + Can do italics, bold, links, …
* Extensions for tables and math via ASCIIMath and TeX

# Learning Math

* Wikipedia
* One Mathematical Cat
* Khan Academy (has a video focus, so less accessible)

# Doing Math

* Desmos – JAWS/NVDA/Mac/iOS -- accessible sophisticated calculator for equations and graphing. Both Nemeth code and UEB input and output. Audio traces for graphs. Also supports generating embossed graphs.
* Mathshare – step by step derivations
* Statistics
* R (use RStudio Server – web-based version)
* SAS has done a lot of work on accessible charts and graphs (JAWS/NVDA/MacOS)
* SPSS – JAWS/MacOS – graphics aren’t accessible

# Biography

Neil Soiffer was a principal architect of MathML, the standard for putting math on the web. He was the main developer of MathPlayer, which is used with

NVDA to make math accessible in Web, Word, and PowerPoint documents. He has published numerous papers on math accessibility and is a member of various

standards groups concerned with accessibility on the Web and elsewhere. He currently chairs the MathML Refresh community group that is working on greater

browser support for MathML along with updating the MathML standard. He received a B.S. in Math from MIT and a Ph.D. in Computer Science from UC Berkeley.

He has worked at Tektronix's Computer Research Lab, Wolfram Research (Mathematica), Design Science (MathType, MathPlayer), and has now formed his own accessibility

company, Talking Cat Software.