This article identifies and discusses key issues and topics around the process of making math accessible for students with a variety of print disabilities.

Instructors and curriculum developers face a set of unique problems when it comes to teaching math to students with varying print disabilities (e.g. blind, vision impairments, dyslexia, etc.). The concept of creating materials that are 'accessible' is one that is widely discussed and researched, but remains relatively undefined by many scholars. Accessibility, broadly defined as "easy to approach, reach, enter, speak with, or use" (Dictionary.com), is often ill defined when it comes to accessible reading materials for students with print disabilities. As a result, it is more often discussed in terms of what the specific issues are, how this can be achieved and in what context it is appropriate to create accessible texts for this particular population of learners.

According to Stoeger, Batusic, Miesenberger, and Haindl (2006) there are four main problems this population of students face when learning mathematics: "1) Access to mathematical literature (books, teaching materials, papers etc.), 2) Preparation of mathematical information (presenting school exercises, writing papers, etc.), 3) Navigation in mathematical expressions, 4) Actually doing Mathematics (carrying out calculations and computations at all levels, doing formal manipulation, solving exercises.)". (pg.1)

For students to be able to overcome these problems, they need to be able to read and manipulate mathematical information in ways that are accessible. Therefore there is a need to translate instructional materials (e.g. instructional text, equations, graphs, etc.) into alternative formats such as audio files, text-to-speech, braille, and/or tactile images, where it is easier for these populations to access and understand the information. The paper Mathematics and accessibility: A survey, written by Karshmer, A., Gupta, G., and Pontelli, E. (2007) provides a good general overview of this topic and the issues related to it.

A variety of technologies and standards have been developed to help make this process easier and more consistent to produce. The NIMAS standard, the DAISY format, the Nemeth code, (Nemeth, 2011; Leas, 2008) and MathML (Miner, 2005), were developed to assist in the translation of mathematical equations into alternative formats. In addition, software products created to assist in the creation or display of accessible math are programs such as MathTalk (Stevens & Edwards, 2007), a system for speaking mathematical equations using speech recognition technology; AudioMath (Ferreira & Freitas, 2005), that uses MathML for speaking mathematics; MathPlayer (Soiffer, 2007), an Internet Explorer plug-in that displays MathML in webpages; Math2Braille (Crombie, Lenoir, McKenzie, & Barker, 2004), which converts MathML
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Mathematical expressions are often spoken in ambiguous forms. MathSpeak is a set of rules for speaking mathematical expressions non-ambiguously. The gh player, now known as readHear, is capable of speaking mathematical expressions non-ambiguously with the MathSpeak rules and is being distributed for free by LearningAlly.

Digital Textbooks and other digital forms of digital reading materials for learning math have emerged as a way of providing digital information in an accessible format. In general, these books provide access to spoken content sometimes with navigation available with voice command. Different from scans (PDFs) of print materials, digital books "can separately represent content and style and can logically structure contents with its searching, linking, and document-styling functions" (Kim, 2010). In other words, include multimedia, and in general they provide text to audio, but some also incorporate image and mathematical expressions to audio as well. These books generally use MathML and the various software components that are able to translate MathML into spoken speech, and there is currently research being done on the use of these books in the classroom.

Another aspect of creating accessible text, especially within mathematics, is the application of images that are supported and/or annotated in ways make them accessible for students who are blind or visually impaired. For example, by providing a verbal description for critical images such as graphs and charts, users who would be otherwise be unable, would have access to information provided by the images. There are several different approaches to creating accessible images such as, using software (MathTrax) to automatically produce image descriptions (Moskovitch, & Walker, 2010), creating tactile representations of graphs (Jayant, 2006), or creating a sonified version of the graph or image (Ramloll, Yu, Brewster, Riedel, Burton, & Dimigen, 2000).

Lewis, S., Noble, S., and Soiffer, N. (2010) summarize:

"Over the last decade, the provision of accessible textbooks has seen a shift from “books on tape” to electronic texts for use with a computer as one of the most effective techniques for providing access to textbook content. This has generally not been true for higher level mathematics content, however, but the advent of Mathematical Markup Language (MathML), and the accessibility protocols to support it, has now made this possible. Now that this capability has been firmly established, the opportunity to study the effectiveness of computer support for reading math is available." (pg. 139)
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The references listed below provide a selection of the published literature on the question of accessibility in mathematics.

We welcome comments, additions, suggestions and feedback on this brief overview. You can add a comment using the fields at the bottom of this page, or write to Mindy Frisbee at mfrisbee@uoregon.edu.

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