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# Accessing Maths and Stats By Other Means

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Historically, it has been the work of talented individuals to produce solutions for those with a variety of disabilities who are working and studying in the field of Mathematics and Statistics. Reading graphs from a screen or paper when blind is a challenge, and coping with complex statistics causes many dyslexic students to blanch. However, there are ways of managing independently and it is often through the use of assistive technology that problems are solved and equal access is maintained.

## ***TechDis***

The Technology for Disabilities Information Service (TechDis) ([www.techdis.ac.uk](http://www.techdis.ac.uk)), has a role to play in enhancing access to this technology by working closely with existing groups in both Higher and Further Education to provide relevant materials for the teaching and learning community; the Joint Information Systems Committee (JISC) provide the TechDis Service, and TechDis will work closely with other JISC services. TechDis will also interact with other bodies, including the Learning and Teaching Support Network (LTSN), with whom TechDis is co-located in York. This article is part of the ongoing process to address the practicalities of making Mathematics accessible through the use of assistive technology, and will contain links to further information.

## ***Software accessibility for the blind: Braille or Speech?***

Being unable to see graphs, shapes, figures and equations, or to cope with the latest software packages available to mathematicians has caused concern to blind students and staff, but a wide range of materials have been developed to help resolve these issues. The use of Braille and/or Nemeth Code ([www.tsbvi.edu/math/math-nemeth.htm](http://www.tsbvi.edu/math/math-nemeth.htm)) for reading mathematical equations and printed material has proved successful at certain levels, and Braille displays linked to computers have made printed text easier to access. However Braille is not accessible to all, and others may use speech output. An example of a program that has a scripting language is Jaws, produced by Freedom Scientific ([www.sightandsound.co.uk/pages/JAWS\\_Features.htm](http://www.sightandsound.co.uk/pages/JAWS_Features.htm)). Jaws is a powerful screen reading program and the latest version will work with Adobe Acrobat version 5 .pdf files, which are often used on the web. Window-Eyes by GW Micro also has this capability ([www.gwmicro.com/](http://www.gwmicro.com/)). Jaws can work with MathTalk ([www.mathtalk.com/products.htm](http://www.mathtalk.com/products.htm)) and provides oral feedback for every command. It can be used in conjunction with Mavis Nemeth Braille Converter or Duxbury Braille translator so that work can be read on refreshable Braille displays or printed out in Braille.

MathTalk with Scientific Notebook depends on using Dragon Dictate Classic or Naturally Speaking, and can cope with over 600,000 voice commands, which can be used with a combination of keyboard/mouse actions. Many mathematical formulae and graphs can be produced with formatting capabilities. The Scientific Notebook, which is included with the program, is powered by Maple. As speech recognition is used, the combination of programs requires high-powered specifications for the best results and the Windows Me version is liable to need at least 256MB. This program can be useful for those with mobility difficulties as well as those with visual impairments. In fact Metroplex Voice Computing, Inc. has produced several programs that can be used with voice commands including VoiceEZcad, which allows for hands free use of AutoCAD ([www.innosolu.com/voice\\_ez\\_cad1.html](http://www.innosolu.com/voice_ez_cad1.html)).

This article and associated links can be found on our web site at:

<http://ltsn.mathstore.ac.uk/access/accessmsor.htm>

### **Tactile graphs**

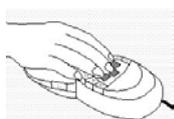
Producing tactile graphs ([www.tsbvi.edu/math/tactile.htm](http://www.tsbvi.edu/math/tactile.htm)) is possible through the use of swell paper, toasters and the Tiger! Different types of paper are available for hand made or printed raised line pictures and both the National Centre for Tactile Diagrams ([www.nctd.org.uk/](http://www.nctd.org.uk/)) and the Royal National Institute for the Blind ([www.rnib.org.uk](http://www.rnib.org.uk)) can provide assistance in this area. The Tiger is an embosser that has WYSIWYG capabilities, so that most black and white pictures or graphs produced on a Windows system computer can be printed out on Braille paper. When combined with DotsPlus (a tactile font), items can be read in the same layout as that seen on the screen ([www.csun.edu/cod/conf2001/proceedings/0128walsh.html](http://www.csun.edu/cod/conf2001/proceedings/0128walsh.html)).

There are times when solutions are introduced by programmers working independently; this has been the case with some tools for Matlab that have been made available by Joshua Miele at Berkeley University ([www.BlindProgramming.com](http://www.BlindProgramming.com)). He has built a set of functions for auditory and tactile data representation from within the Matlab environment. The auditory function is handled by any standard sound card, and the tactile capability consists of graphical output to any graphics-capable embosser. However, it must be said that at all times those who are blind and wish to study science based courses will always need to find a 'work around'; this requires time, skill and patience. To quote Prof Jon Gardner, Science Access Project,

*"There are promising developments on the horizon, but as of today there is no math reading or writing program that is really accessible except for some made especially for blind people"*  
(e-mail June 1<sup>st</sup> 2001).

In the UK several research projects have been undertaken including the Mathematical Access for Technology Science for Visually Disabled People ([www.cs.york.ac.uk/math/york\\_math.html](http://www.cs.york.ac.uk/math/york_math.html))

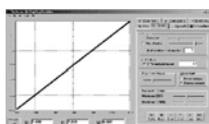
### **VirTouch mouse**



Feeling the way around a drawing, graph or geometrical figure on a screen can also help and this is possible with the VirTouch mouse. This tool even enables the drawing of symbols, icons, graphic schemes. The 3 displays on the body of the mouse consist of rounded pins that rise and fall as the cursor scans the screen, reflecting the images on the computer display. The mouse is quite large but feels very comfortable. At present the mouse is only available from Virtouch ([www.virtouch.co.il/vts.htm](http://www.virtouch.co.il/vts.htm)).

### **Large type and talking calculators**

Large type and talking calculators can help those with dyslexia as well as those with visual impairments. These calculators vary from the basic on-screen versions requiring Windows or Mac systems such as the Big Friendly Calculator (downloadable free from Learning and Teaching Scotland: [www.scet.com/products/freeware.asp](http://www.scet.com/products/freeware.asp)) to the more complex audio-accessible graphing calculator resulting from the Science Access Project at Oregon State University ([www.csun.edu/cod/conf2001/proceedings/0129walsh.html](http://www.csun.edu/cod/conf2001/proceedings/0129walsh.html)).



The latter has an audio tone output that allows the user to hear the position of the navigational marker as it is moved across a graph with various pitches for the different parts of the diagram. A screen reader is needed to achieve audio output and this program only works in Windows.

There is a useful web page concerning other accessible calculators to be found at the Scientific Research Unit [www.tiresias.org/equipment/eb11.htm](http://www.tiresias.org/equipment/eb11.htm)

Hand held talking calculators with large keys are also available and once again the RNIB have a selection ([www.rnib.org.uk/technology/factsheets/lowtech.htm](http://www.rnib.org.uk/technology/factsheets/lowtech.htm)). The scientific versions tend to have over 50 functions and are suitable for degree level Mathematics. The calculators with larger keys can also help those with dexterity problems.

### **Maths drawing program**

AccessMaths ([www.ace-centre.org.uk/html/accmath1.html](http://www.ace-centre.org.uk/html/accmath1.html)) is a maths drawing program designed to be used with any type of mouse or track ball and can also be accessed by use of a concept keyboard which is a flat board with linked navigational areas. The program allows for the construction of lines, squares, rectangles, circles, semi-circles, ellipses, triangles (equilateral, isosceles and scalene), polygons (regular and irregular), parallelograms, arcs and pie charts, all of which may be annotated by arrows and text. The software is designed for pre-college aged students but, as it can be used by Switch users (for example those who access the computers command and navigational levels with single clicks on a large button or head pad), it may be the only option for someone with severe mobility difficulties. In fact if dexterity issues arise it is not always possible to use a mouse accurately, and shortcut keyboard commands can be more effective (these may be found under the Windows help file; judicious use of Auto text and macros can also help.)

**Text to speech**

Many students with dyslexia find mathematics and statistics difficult and Jan Poustie has produced several books on the subject, which are available from her company's web site at [www.janpoustie.co.uk](http://www.janpoustie.co.uk). She has written specifically about assessing for dyscalculia in her book 'Mathematics Solutions - An Introduction to Dyscalculia Part A'. For those who find reading accurately from a screen hard to achieve, text to speech software such as Read and Write ([www.texthelp.com](http://www.texthelp.com)) can help. This program can be set so that as numbers are typed into a spreadsheet program they can be read back either individually or in a string. Magnification programs can also enhance access with various coloured background and font options. There are many different types of programs that fulfil this task, and these vary from the options available in Read and Write to the programs suitable for those with visual impairment such as ZoomText from Sight and Sound ([www.sightandsound.co.uk](http://www.sightandsound.co.uk)) or Lunar from Dolphin ([www.dolphinuk.co.uk/](http://www.dolphinuk.co.uk/))

In a seminar or lecture setting there are many students who have difficulties seeing, hearing or coping with the speed at which items are put up on a black or white board. Complex algebraic or mathematical formulae require careful copying and in a technological age, if these items are written on an electronic board such as the mimio ([www.copyboards.co.uk/pages/boards05.htm](http://www.copyboards.co.uk/pages/boards05.htm)), they can be downloaded directly to a student's laptop, where appropriate software and hardware can be used to make that information accessible.

**Speech to Print**

Deaf students who have access to Computer-Aided Speech-to-Print Transcription Systems are able to have a hearing operator transcribing spoken lectures onto a laptop computer using a word processing program, and an abbreviation software program like Productivity Plus. The laptop may be connected to a television monitor to be viewed in real time by students in the class, and the lecture is stored in memory and can be printed as notes for student reference.

**Conclusions**

As can be seen

*"access by people with print disabilities to information is markedly enhanced if the information is created and made available on computers..."* (Gardner, J.A., 2001)

and if mathematics is inaccessible it can affect many people's ability to join the employment market or progress in other aspects of the educational world. This pressure is added to by the forthcoming legal obligation provided by the Special Educational Needs and Disability Act; from 1 September 2002 it will be illegal for any institution to discriminate against students on the grounds of disability and as such all aspects of mathematics education must be accessible. Further details can be found on the TechDis website ([www.techdis.ac.uk/](http://www.techdis.ac.uk/)) and many of the products mentioned with links to further information can be found on the Database. The DO-IT program at Washington University have a series of videos including 'The Winning Equation: Access +Attitude = Success in Math and Science', for viewing on-line which further explains the uses of Assistive Technology ([www.washington.edu/doi/Video/](http://www.washington.edu/doi/Video/)).

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