Workshop report…Visual impairment in maths, stats and operational research (MSOR)

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A workshop on Visual impairment in Maths, Stats and OR (MSOR) was offered by the MSOR Network through the Accessing Maths, Stats and OR (AccessMSOR) Working Group and the AccessMSOR: LaTeX and Braille mini-project. This one-day workshop took place at Nottingham Trent University on Thursday 17th December 2009.

The workshop explored issues surrounding access to and interaction with mathematical content by visually impaired students. Participants included academics and technical staff interested in learning more about visual impairment, and disability support staff and researchers interested in learning more about MSOR subject-specific issues. The opening session included a hands-on activity to aid understanding and a group discussion of some of the issues faced by visually impaired students in MSOR subjects. Following this, the workshop looked at some ways technology can be used to support teaching and learning for such students. Sessions offered practical advice and looked at cutting-edge technological solutions and their technical and practical limitations.

The workshop was made up of five sessions. Short summaries of the workshop sessions are provided by each speaker below and the slides are available on the MSOR Network website using the link at the bottom of this article.

Issues facing students with visual impairments accessing MSOR content

Emma Rowlett and Peter Rowlett, University of Nottingham

Students with visual impairments use a variety of reading methods, and some of these may also be used to produce content. These are known as 'alternative formats'. Table 1 shows how popular different alternative formats are amongst those registered blind or partially sighted. Many people have a 'preferred format' but may use different formats or a mixture of formats depending on the situation.

Reading method	Blind	Partially sighted
Ordinary print*	28%	55%
Large print*	45%	67%
Braille	9%	3%
Moon	1%	1%
Talking books	90%	59%
Screenreader	10%	5%
Human reader	58%	33%

* Reading with or without a magnifier

Table 1 – Usage of different reading methods among blind and partially sighted people [1]

Braille: Braille is made up of 'cells' containing 6 or 8 raised dots. Many incompatible standards exist for mathematical Braille, it can take longer to read and may be conceptually difficult.

Clear/large print: Increasing the font size is rarely sufficient to create clear/large print. Most users also require changes to spacing, layout, font, colours, etc. Generally 14 point font is preferred for clear print and 16 point font or above is preferred for large print. For both, sans serif fonts are generally preferred (e.g. Arial, Verdana); however maths notation often uses serif fonts (e.g. Times New Roman, Garamond).

Graphics: Access to complex graphics can be difficult. Tactile versions, written and verbal descriptions may be used, often in combination.

Magnifiers: Hand-held lens magnifiers, as well as electronic and software versions, may be used to read standard or large print text. However, it may be difficult to get an overview of a document or mathematical expression.

Speech: Screenreader software converts text content displayed on screen to speech, but often struggles with maths and automated voices can be difficult to concentrate on. Support workers can act as readers but are less flexible and require subject-specific knowledge. Speech can be ambiguous and listening requires holding a lot of information in working memory.

Software: Some software is accessible using screenreaders that create aural output or using alternative input methods such as voice recognition or keyboard shortcuts that negate the need to use a mouse (which requires vision). However, MSOR subjects may use specialist software not accessible using these alternative methods. Some students work with a sighted reader to access software programs, or use alternatives to standard software if the teaching is flexible enough to allow this.

Funding: Many students are eligible for Disabled Students Allowances (DSA) or similar funding to pay for extra course-related costs, such as specialist equipment, assistive technology, support workers and transcription to alternative formats. However, DSA may not cover everything that is needed and institutions still have a role to play in making reasonable adjustments.

Access to materials is a key issue for students. Reading lists and lecture notes are needed sufficiently in advance and source documents need to be obtained or turned into editable versions that can be converted into alternative formats. Reliability of conversion and proofreading are important considerations.

Problems accessing written materials can mean students find it difficult to read around the subject. Teaching methods using chalk and talk are particularly inaccessible (although good for most students) and PowerPoint also has accessibility problems. Advance lecture notes can help, as can delivery that avoids pointing and saying "this" – e.g. "this expression differentiates to this".

In tests and examinations, extra time may be needed and students may benefit from the assistance of a support worker. Extensions to coursework may help but can cause problems unless an overall extension to the course is available.

All students are different and supporting disabled students means accommodating individual needs. It can be helpful to talk to the student; they may be the best person to know how to deal with their needs/requirements.

You can read more about the issues surrounding access to mathematical content by visually impaired students in a previous article in MSOR Connections [2].

Evaluating and using emerging technologies to enable access to MSOR content

Emma Cliffe, University of Bath

Students provided with assistive technology through Disabled Students Allowance (DSA) may find it less effective for MSOR content. In PDF or Word documents MSOR content cannot be accessed by screenreader, output in Braille or easily manipulated to create large/clear print formats. Standard Optical Character Recognition (OCR) cannot recognise formulae to compensate.

A small trial was conducted of some newer technologies for accessing MSOR content. MathType for Word can control the font, fontsize and colour of some formulae authored in Word. To support authoring, formulae can be input using mouse only or keyboard only, stored, copied and pasted to and from some applications/webpages and displayed with scope highlighting. Documents can be exported as MathML and read aloud via MathPlayer which also interfaces with commonly used screenreaders and literacy support software.

InftyReader provides OCR of cleanly printed MSOR content with output in LaTeX, MathML or Word 2007 formats. InftyEditor provides a powerful environment for proof reading OCR output – a necessity as small errors can completely alter the meaning of formulae. ChattyInfty, an editor with audio interface (and LaTeX output to a Braille display) when used with InftyReader can provide independent access to resources with which a student is confident as well as an accessible authoring environment. Information on the Infty family of software is available from InftyProject [3].

While new levels of access can be achieved it was found that the interface to other assistive technologies might be untested and that training would be required to promote efficient and effective use. MSOR specialists may have a role in bridging this gap – unless the difficulties of using standard assistive technology for *MSOR content* are understood then alternatives will not be sought or supplied and training will not be available. Perhaps for these reasons the technologies trialled are unlikely to be provided via the DSA hence institutions may have a role in technology provision.

You can read more about Emma's work using technology to improve access to mathematical resources and associated issues in a previous article in *MSOR Connections* [4].

Lambda: Linear access to mathematics for braille devices and audio synthesis

Alistair Edwards, University of York

Visual notation, such as algebra, represent a barrier to visually impaired students. Two European-funded research projects *(Maths and Lambda)* have addressed the problem of providing competent mathematicians (i.e. those around A-Level standard) with access to algebra. The latter project has resulted in a commercial product, the Lambda Editor [5] which achieves this – to some extent.

The principle behind Lambda is that the mathematical representation should be linear, because that translates naturally into either braille or synthetic speech. The resultant *Lambda Code* is essentially a linearized and simplified version of MathML. It uses new visual symbols which translate directly, one-to-one into 8-dot Braille and speech. Evaluation has found that continental European students much prefer the Braille rendering (even though it is a new and 8-dot notation) while British students prefer the spoken representation.

Students can input mathematics into the Editor, which is a Windows application, using the keyboard and a set of accessible menus. They can also manipulate the material using conventional editing operations, along with some mathematical manipulations. Flexibility is key, particularly as opinions differ as to how much of the mathematics the students should perform for themselves. For instance, the built-in calculator facility has to be optional for most teachers.

Lambda has been a success in that it is a commercial product and it does address a real need for students – albeit a small number – who have already reached a high level of competence in mathematics. The real remaining challenge is to spread access to elementary mathematics to a larger number of younger students.

LaTeX to Braille and speech conversion with BrlTeX

Michael Whapples

The presentation started off by discussing the history of BrlTeX [6], stating the original requirements of what BrlTeX should do and the original reasons for creating BrlTeX. The main requirements were listed as: produce accurate British maths Braille from LaTeX; warn the user of any unknown LaTeX commands, and other potential errors; open source so that the user could correct any inaccuracies in BrlTeX's translation; and, to be ready to use as soon as possible. While these goals were met early on, it was felt that BrlTeX was limited in its usefulness to other users due to limitations such as it only producing British maths Braille and due to the speed at which it had been developed it was not designed with flexibility of adding extra output codes.

As part of the project "Accessibility in MSOR: LaTeX and Braille" further development of BrlTeX was undertaken to try and remove some of the limitations of BrlTeX and so make it more useful to other users. To show that BrlTeX is able to produce other output formats, a speech output module was produced for BrlTeX as well as the British Braille output module. The presentation contained a demonstration of the output from both modules.

The presentation concluded by discussing the possible future of BrlTeX. While BrlTeX works, there are still some elements of it which feel like they could do with further development. One such area which could do with improvement is in the user interface as BrlTeX is a command line tool and does not lead the user through the process of producing a Braille document. One of the reasons why some of the lacking features have not received attention is that the development of BrlTeX has required more work than expected. As there are some promising tools out there, for example liblouisxml, it is being considered whether to try and change the direction of BrlTeX development so it can make use of other project's work to allow attention to be spent on developing the lacking features.

You can read more about the development of BrlTeX in a previous article in *MSOR Connections* [7].

TalkMaths – the challenge of designing a speech-driven mathematical content editor

Eckhard Pfluegel, Kingston University

The TalkMaths project was initiated by Eckhard Pfluegel due to his need to use speech recognition in order to perform specialist tasks such as entering or modifying mathematical equations using the mathematical typesetting language LaTeX. Together with his colleagues Gordon Hunter and James Denholm-Price at Kingston University he embarked on a research project involving a number of MSc and PhD students that resulted in the prototype.

TalkMaths application (available for public download at [8]). The software is implemented in the scripting language Python and requires Dragon NaturallySpeaking (DNS) Version 10 to be installed on the user's machine. The interface to DNS is realised using a free library which means that TalkMaths can be used even with the "preferred" version of DNS.

TalkMaths provides a speech-driven user interface for creating and maintaining mathematical expressions. Its current functionality covers spoken input of mathematics to the level of approximately GCSE maths syllabuses, with a focus on algebra. Editing of previously created mathematical documents is supported, however this functionality will be greatly improved in upcoming releases of the software.

A recent investigation, which was the main aspect discussed during the presentation at the MSOR workshop, examined the suitability of TalkMaths for users with visual impairments. Here, TalkMaths can already help since mathematical input can be dictated, hence removing the need to use traditional keyboard or mouse. Rendering of the equations can be done with arbitrary font sizes, controlled by voice, which would suit a user who has some level of vision. The missing key feature is audio playback of the currently edited expression. Ultimately, speech-audio navigation of mathematical expressions, similar to that of other screenreader software, for example MathPlayer, is a goal for our system. This issue was explored and discussed during the workshop and it gave valuable suggestions for future developments in this area.

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Editorial Comment

Slides of all five presentations are available on the MSOR Network website via: http://www.mathstore.ac.uk/index.php?pid=274

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