Use of effective assistive technology in a mathematics learning support context

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Mathematics support...

- Reading mathematics
- Doing mathematics
- Note taking and lectures

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Who provides the support?

Disabled Students Allowance (DSA)

- Helps pay for disability related extra costs of studying
- Help towards the cost of
  - Items of specialist equipment
  - Non-medical human support
  - Other course-related costs

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Funder confirms eligibility	$\longrightarrow$	Needs assessment identifies require-ments	$\longrightarrow$	Funder confirms level of help from DSA

Disability Discrimination Act

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Requirements to

- Make reasonable adjustments to ensure disabled students are not at a substantial disadvantage
- *Anticipate* changes which may be required and be proactive in making them
- Meet reasonable unanticipated requirements of individual students

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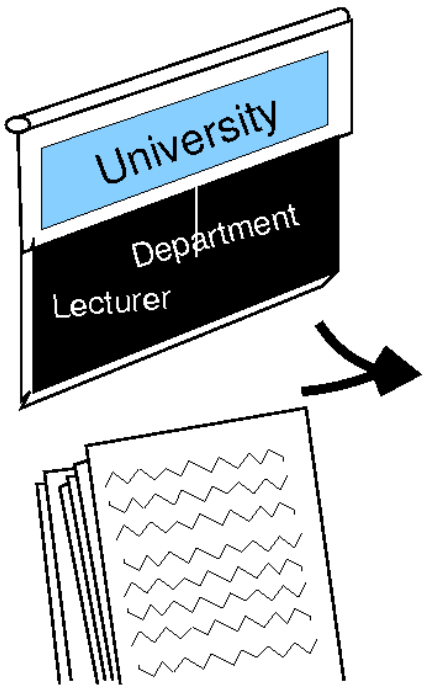
- Reasonable adjustments may be required in addition to resources provided by the DSA
- Equipment provided by the DSA might make other adjustments reasonable

Access to learning resources



To access learning resources a student might require

- Reasonable adjustments made by the institution

together with

- Assistive technology
- Human support

Examples of AT provided through DSA

Software/hardware for

- Literacy support
- Mind mapping
- Scanning/Optical character recognition

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- Magnification
- Audio production
- Braille production

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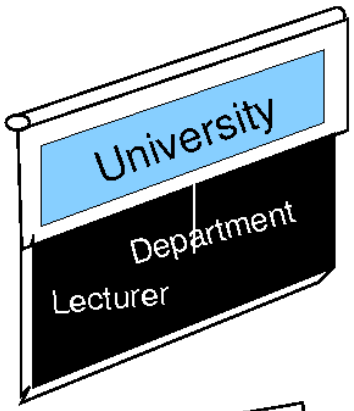
- Audio production
- Braille production
- Dictation
- Notetaking
- ...
- JISC TechDis: `http://www.emptech.info/`

The technology gap

Maths, Stats & OR Network AccessMSOR WG:

- Mathematical text conversion and recognition
- Inputting mathematics
- Mathematics in e-books
- Mathematics on VLEs, wikis and blogs
- MSOR software accessibility

The technology gap



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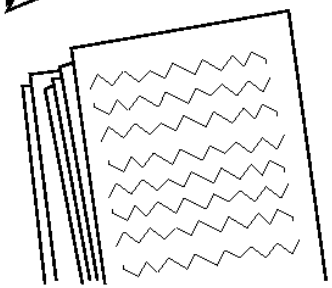

Production of accessible mathematical resources is difficult

together with

Lack of assistive technology

- Current: limited access to mathematics
- Slow impact of research and development

?

Reading mathematics

To support reading we might need to produce:

- Flexible visual electronic format
- Audio with or without synchronised highlighting
- Braille

Flexible visual formats

Large print doesn't just mean large...

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- RNIB clear print guidelines

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- For mathematics?

Flexible visual formats

Large print doesn't just mean large...

- RNIB clear print guidelines
- For mathematics?
- Using LaTeX or Word:
  1. Producing required formats is challenging!
  2. Re-flow problem
  3. PDF an inflexible format

11pt

Example 1. *Find the quadratic mean of* $1, 2, 3, 4, 5, 6, 7, 8, 9, 10$*:*

$$\begin{aligned}\sqrt{\frac{1}{10}\sum_{i=1}^{10} i^2} &= \sqrt{\frac{1^2+2^2+3^2+4^2+5^2+6^2+7^2+8^2+9^2+10^2}{10}} \\ &= \sqrt{\frac{1+4+9+16+25+36+49+64+81+100}{10}} \\ &= \sqrt{\frac{385}{10}}\end{aligned}$$

14pt

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17pt

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20pt...

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$$\sqrt{\left(1 + 4 + 9 + 16 + 25 + 36 \right.}$$

A partial solution

- A different approach: use **MathType**
- Can we convert to other formats?
- Can we use with assistive technology?

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- Can we convert to other formats?
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- What about all the documents written in LaTeX?

Screen readers and mathematics

Screen reading software sometimes doesn't work:

- **JAWS reading a PDF**

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- LaTeX: **JAWS reading LaTeX source**
  1. Complex mathematics difficult to navigate
  2. Commands for presentation mixed with content

The difference MathML makes...

We can convert mathematics created with **MathType** to:

- HTML + MathML read using IE and **MathPlayer**

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- A MathML enabled Daisy book using **MathDaisy**

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But

- Complex mathematics is difficult to navigate
- Description of notation rather than name of the object
- There is no Braille support

What about PDF and print?

- Text PDF: theoretically accessible but most aren't
- Image PDF: inaccessible
- Print hard copy is scanned to produce images
- Mathematics on the web might exist only as images

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Images $\xrightarrow{\text{OCR}}$ Text which might contain errors

Optical character recognition

For instance, suppose we need to recall that

$$(x+a)^n = \sum_{k=0}^{n} C_k^n x^k a^{n-k}$$

where

$$C_k^n = \frac{n!}{(n-k)!k!}$$

Optical character recognition

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- **InftyReader and ChattyInfty**

  For mathematics this would be the OCR of choice — to stick in a piece of paper that you didn't know the context of... knowing that InftyReader is powerful — this is the most powerful thing that I have.

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- Navigation is a problem
- Some people choose to read and write LaTeX

Cleaning up LaTeX sources

```
\noindent {\bf 5.}\quad {\bf $\Theta$-notation (reminder)}
\medskip

\noindent {\bf Definition} ($\Theta$-notation).
$ \Theta \bigl( g(n) \bigr) = \{ f(n):$ there exist constants
$c_1>0, c_2>0, n_0>0$ such that $c_1 g(n) \le f(n) \le c_2 g(n)$
for all $n \ge n_0 \}$.
\medskip

\noindent {\bf Convention.}\quad If $f(n) \in \Theta \bigl( g(n) \bigr)$,
then we write: $f(n) = \Theta \bigl( g(n) \bigr).$
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\noindent {\bf Lemma.}\quad {\sl If $f(n) = \Theta \bigl( g(n) \bigr)$,
then $g(n) = \Theta \bigl( f(n) \bigr)$.}
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\noindent {\bf Proof.}\quad The inequality
$$0 \le c_1 g(n) \le f(n) \le c_2 g(n)$$
for $n \ge n_0$ implies
$$0 \le (1/c_2) f(n) \le g(n) \le (1/c_1)f(n).$$
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 5.  \Theta-notation (reminder)

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such that c_1 g(n) <= f(n) <= c_2 g(n)
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- We use MSOR hardware/software to support us
- Writing mathematics: LaTeX or Word

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- MSOR software may not be accessible when using dictation or a screenreader

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In a format which can be made accessible!

> *I thought a PDF would be accessible since it is an electronic format...*

Research, development and good practice

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- Focus on MathML

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- We need to share knowledge and expertise

Thanks!

Questions, comments and your experiences