Creating accessible mathematics content

Mathematics Teaching and Learning Seminar

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Today's aims

1. What is accessibility?

2. Signpost tools that focus on technical aspects of mathematics accessibility.

   • LaTeX and accessibility.

   • Other approaches.

3. Highlight resources.

Huge area, not everything will be covered today.

What is accessibility?

Legal	Positive for all
A product or services can be used by everyone, no matter how they engage with it.	Has benefits for all: availability of material, structure of resources, flexibility of engagement.
- Public Sector Bodies (Websites and Mobile Applications) (No. 2) Accessibility Regulations 2018.	Encourages new ways to think about inclusive education
- Equality and Human Rights Commission (EHRC) enforce this provision and Government digital services (GDS) accessibility audits.	University and society sees accessibility as a priority

LaTeX

Technical point of view: LaTeX + PDF

Almost all accessibility requests are clear print PDF or large print PDF.

- **Font size:** clear print ideally 14pt, large print ideally 18pt. (Not photocopied.)

- **Font:** Arial, or equivalent

- **Font shape:** no italics, underlining or big BLOCKS OF CAPITALS.

- **Left aligned text.**

- **Line spacing:** 1.5 recommended.

- **High contrast colours.** Contrast checker

Demo

Technical point of view: etoolbox

LaTeX's **etoolbox** allows for parameterised documents/changing font/appearance etc

```
\usepackage{etoolbox}
\newbool{clearprint}
\boolfalse{clearprint}
%\booltrue{clearprint}% uncomment if required
\ifbool{clearprint}{% fork for packages, before document
        \setlength{\parindent}{0.0pt}
        \setlength{\parskip}{1.0\baselineskip}
        \renewcommand{\emph}{\textbf}
        \usepackage{helvet}% for PDFLaTeX
        \renewcommand{\familydefault}{\sfdefault}% for PDFLaTeX
        \usepackage{setspace}
        \onehalfspacing
        % 14pt/18pt font in PDFLaTeX takes some effort: memoir/scrbook
        % but this is a document class change.
   }{} % the 'else' is left empty here
```

```
%XeLaTeX provides better font control
\usepackage[fontsize=14pt]{scrextend}
\usepackage{fontspec}
\setmainfont{Arial}
```

So done?

So done? LaTeX PDF documents

Use keyboard rather than mouse	No (Tagging)
Adapt content to needs (contrast, dark mode)	Maybe
Use a screenreader (don't assume)	No
Alternative text for images, charts, diagrams etc	No
Screen magnification	Yes
Voice commands	No

Technical point of view: LaTeX + PDF

- LaTeX does not produce accessible PDF output: removes structural integrity of the content, semantics of equations removed.

"The event A has probability $\dfrac{4}{36} = \dfrac{1}{9}$ and the event B has probability $\dfrac{6}{36} = \dfrac{1}{6}$."

Is actually "4161 The event A has probability $36 = 9$ and the event B has probability $36 = 6$."

- It is not just equations: tables, sections, figures etc are all a problem.

- LaTeX is Turing complete so not unexpected.

Technical point of view: maths

Three accessible formats

- **Word**: with the Equation Editor to create equations, not the focus of today.

- **HTML**: with MathJax to render mathematics.

- **EPub3**: least supported format, not the focus today.

Technical point of view: HTML

Works with any Accessible Rich Internet Application (ARIA) aware screen reader (JAWS/NVDA).

- Navigation, chunking, zoom, copy/paste, colour, size and layout changes.

- Structural integrity enables assistive technology including text-to-speech, screen readers, electronic Braille.

- All browsers.

Moodle already uses MathJax to render equations, so provided you use LaTeX: \(x^2\) not

x^2 to enter equations

- Quizzes

- Forums etc

Demo

Retrofitting accessibility

LaTeX → "Magic" → Accessible HTML document

Retrofitting accessibility: Pandoc

Pandoc is a universal document converter

LaTeX to HTML

```
pandoc lecturenotes.tex --number-sections —standalone
        —mathjax -o lecturenotes.html
```

LaTeX to Word

```
pandoc mydoc.tex -o mydoc.docx
```

Demo

Retrofitting accessibility: LaTeXML

LaTeXML (or LaTeXML) can produce accessible HTML from existing tex files

LaTeX to HTML:

```
latexml —dest=notes.xml notes.tex

latexmlpost —format=html

          —-javascript=LaTeXML-maybeMathJax.js

            notes.xml

          —dest=notes.html
```

Demo

So done?

Retrofitting accessibility: Pandoc & LaTeXML

- Conversion is **not perfect**.

  - Some LaTeX packages/commands will not work (\xymatrix,\hfill); there is no HTML or Word equivalent.

  - LaTeXML has known bugs.

  - Avoid "input", "include", "graphicspath".

- Expect manual checking after the conversion, followed by

  - Revisions of LaTeX file

  - Changing environments/packges

- Work still required for image alternative text.

  - LaTeXML puts figure captions as alt-text, but removes any maths content!

So done?

Use keyboard rather than mouse	Yes
Adapt content to needs (contrast, dark mode)	Yes
Use a screenreader (don't assume)	Yes
Alternative text for images, charts, diagrams etc	Yes -ish (provide all have captions suitable for alt-text)
Screen magnification	Yes
Voice commands	Yes

Retrofitting accessibility: alternative tex

- LaTeXML uses caption text as alt-text.

- Alt-text is not necessarily the same as a caption.

  - Alt-text is not visible on a website while captions are visible below the image.

  - Alt-text is read by screen readers in place of images and must convey a description of the image for someone who cannot see the image.

  A caption might say "Graph of $f(x) = \sin\left(\dfrac{1}{x}\right)$ for $x > 0$."

  This is not suitable alt-text.

  - So, work is required on captions/alt-text.

Accessible Handwriting

- Handwriting is not technically accessible.

- [Mathpix](#) can read handwritten mathematics and convert it to a variety of accessible formats.

  - Either write directly on the app.

  - Take a photo.

  - Scan a PDF.

Let $\Omega=\left\{\left(\omega_{1}, \ldots, \omega_{n}\right)=\omega \mid \omega_{i} \in\{1, \ldots, r\}\right\}$. Then by the fundamental muitiplication rule we have $|\Omega|=\underbrace{r \times \ldots \times r}_{n \text { times }}=r^{n}$

Let $A_{k}=\{\omega \in \Omega \mid \omega(i) \neq k \quad \forall 1 \leqslant i \leqslant n\}$. Then $\left|A_{k}\right|=(r-1)^{n}$ (See Example 2.43). Since each sequence is equally likely, we have $\mathbb{P}\left(A_{k}\right)=\frac{\left|A_{k}\right|}{|\Omega|}$. Hence , $\mathbb{P}\left(A_{k}\right)=\frac{(r-1)^{n}}{r^{n}}=(1-1 / r)^{n}$.

Accessibility by design

- Inclusive and accessible documents by design are effective and more efficient.

- R Markdown and Bookdown provide a markdown alternative.

  - LaTeX for the equations and "markup" for the document.

  - Focus is on content, templates control document properties and appearance.

  - Can specify alternative text during construction.

  - Can produce PDF, HTML, Beamer, Word etc formats from one document.

- Example lecture notes (external page).

Demo

Summary

Output	Accessible?	Also	Comments
PDF	Not with LaTeX	Provide clear print and/or large print in electronic form	Provide all at the start: reduce the queries.
HTML	Yes, with MathJax	Think about captions and alt-text for images	• Use LaTeX in Moodle. • Use Pandoc or LaTeXML to convert. Check the output. • RMarkdown/Bookdown to do everything at once
Handwriting	No	Make accessible with Mathpix	
Video captions	Auto generate	Add statement to Moodle regarding autogenerated captions.	

Our approach

- We have people who invested time to test ideas and create an "accessible by design" approach.

- We used and trained our students to help convert materials: summer interns.

- Recommend statement on Moodle pages:

  - Captions are autogenerated, who to ask if there are queries.

  - Who to contact if some material cannot be accessed.

- Haven't covered: Desmos, BrailleR, Data Sonification, how to write alt-text.

- "How to Resources" at the end of the presentation

Questions

Resources

Resources

- University's Accessibility Workshops

- University's Moodle support guides

- Good Practice on Inclusive Curricula in the Mathematical Sciences (2012)

Resources: LaTeX + PDF

- PDF accessibility and tagging.

- LaTeX PDF accessibility and PDF standards.

Resources: Moodle part 1

- Moodle accessible course formats

- Moodule creating accessible content

- Moodle images: alt text and text alternatives

- Moodle accessibility quick guide

- Using clear and concise language

- Using meaningful link text

- Using Moodle accessibility tools

- Using sections to organise content

Resources: Moodle part 2

- Using LaTeX or the Equation Editor with Moodle.

- Create Moodle quizzes directly from LaTeX using the Moodle package.

Resources: Pandoc

- Pandoc provides [example conversions](#).

Resources: RMarkdown and Bookdown

- Instructions on [making Lecture notes with Bookdown](#) includes a workflow from LaTeX to Bookdown.

- [R as a basis for writing accessible mathematics](#) delivered at CETL-MSOR 2019.

- A comparison of [Markdown vs LaTeX](#).

- [A web page created using R Markdown](#) and the [source code for the same web page](#)

- [Teams Bookdown usergroup](#)

- [Accessible R Markdown Documents](#) written by the author of BrailleR.

- A [R Markdown Thesis](#) Template from Oxford University.

Alternative text

- [DIAGRAM Center](#) provide guidance and example alternative text descriptions including for [complex images](#) and the [UK Association for Accessible Formats](#) provides standards and guides.

- Examples for creating alternative descriptions/representations for [Finite-state Machines diagrams](#).

- [How to describe images](#) provides a wide range of different examples and guidelines for descriptive text. Think of this as a training resource.

- [How to make a Klein Bottle from an old pair of jeans](#)

Interactive figures

- Desmos is free and built for accessibility. For example, Braille support, audio trace, maths aware voice over, tactile diagrams, screen reader.

- BrailleR has lots of ways to present data in accessible ways. For example:

- Data sonification represents data by sound.

Programming with LaTeX

- [Basic interpreter in TeX](#)

- [Mars rover](#)