

Tools for Creating OER Part I: Using Text-Based Tools

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Introduction

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- ❖ Ghostwriter
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- Currently using **open** coursebooks in four courses
 - ⇒ **Statistics** and **Calculus I and II** and **Linear algebra**
 - ⇒ Jointly written by me and Fotini Labropulu
- This talk will focus on use of **plain text-based tools**:
 - ◆ **L^AT_EX** Documentation System
 - ◆ **Pandoc Markdown**
 - ◆ **PreTeXt**
 - ⇒ Development of **textbooks** particularly in mathematics and science.
- All tools are **open source** and **freely available**
 - ⇒ And run on **your own computer**.
- Will consider our **experience**
 - ⇒ And where going **next** . . .

Why Open Textbooks?

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- Cost to student?
 - ⇒ Saved my statistics students \approx \$90,000 over five years.
- Modern **print technology** makes **custom** textbooks possible.
 - ⇒ External through **print on demand**
 - ⇒ Internal through **institutional** printing
- **Electronic documents** (for web browsers and e-readers)
 - ⇒ Allow for even more rapid change and variation.
- **Content** Customization **desirable** for many reasons:
 - ◆ Text **directly follows** course being taught.
 - ⇒ Text can be **manageable size** and brought to class
 - ⇒ So data table, theorem, or graph can be **included**
 - ⇒ More **time** for in-class work (problems, quizzes)
 - ◆ Text should have **local relevance**.
 - ⇒ **Biological** examples of Saskatchewan **flora** and **fauna**
 - ⇒ **Administration** examples of **public utilities**, **co-ops**
 - ◆ Text should reflect **student context**.
 - ⇒ Statistics for **nursing**, **business**, or **science**
 - ⇒ Topics and technical abilities will vary
 - ◆ Text should reflect **your interests** as an instructor.

***L**A_T**E**X: A Text-based Typesetting Language*

- Word-processors are an example of **WYSIWYG** development.
 - ⇒ **What You See Is What You Get.**
 - ⇒ Rolls together tasks of **content generation** and **presentation.**
- Inherent limitations:
 - ◆ You may not be good at both!
 - ◆ You may want **same content** in **different modalities**
 - ⇒ print, HTML (web), e-book, etc.
- Common Math/Science publishing standard is **L**A_T**E**X
 - ⇒ A **typesetting** computer language created by **Leslie Lamport**
 - ⇒ Built on top of **T**E_X (**Donald Knuth**)
- One writes a **text file** with commands like
This is `\emph{Gauss's Law}`:
 `$\oint \vb{E} \cdot \vb{dA} = \frac{Q}{\epsilon_0} $`
- This gets **compiled** (`pdflatex myfile.tex`) to a **PDF** document as:
This is *Gauss's Law*: $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0}$.
- The **L**A_T**E**X compiler is an **open source** program.
- So creating a document is like **writing software.**
 - ⇒ A **source** text document creates an **object** PDF document.

L^AT_EX Benefits

“Everything should be made as **simple as possible**, but **not simpler.**”

- **Complicated structure** of a textbook,
- **Dynamic nature** of open content,
⇒ Requires **appropriate tools** for text production.
- L^AT_EX does **science professionally**
⇒ Equations, theorems, tables, graphics, hyperlinks
- Has the tools to **automate** production of
 - ◆ Table of contents
 - ◆ Bibliography
 - ◆ Index
 - ◆ Glossaries
 - ◆ Cross-referencing (figures, tables, equations)
- Exclude a chapter?
⇒ Everything updates automatically.

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L^AT_EX Benefits

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- Switches for appearance (e.g. vectors as \vec{v} , \bar{v} , \hat{v} , or \mathbf{v})
- Can contain multiple versions of textbook in same document.
 - ⇒ A switch for content:
 - ◆ international textbook or local textbook
 - ◆ teacher's edition or student edition
 - ⇒ A switch for output style:
 - ◆ black-and-white print version
 - ◆ colour print version
 - ◆ electronic version with hyperlinks (videos, simulations) or extra content (proofs, data, code)
 - ⇒ Switch for ancillary documents:
 - ◆ Production of slides
 - ◆ Production of solutions manual

L^AT_EX Benefits

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- L^AT_EX separates task of content production
⇒ From formatting and layout.
- In theory, authors only worry about content.
⇒ L^AT_EX language knowledge required minimal.
- Someone else (publisher) worries about formatting issues.
⇒ More technical knowledge required here.
- Example: Students writing theses at U of R in L^AT_EX
⇒ Just load the U of R thesis document class
⇒ Never need to look at thesis formatting guidelines
⇒ Choose a bibliography style *after* thesis is written.
- For textbooks a common set of formatting/layout tools
⇒ Should be produced to facilitate book production.
⇒ All textbooks could be given a common look/shape.
⇒ Improvements to layout get made in a single location.

L^AT_EX Challenges

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- Some features of textbooks are **unique**
- Fortunately L^AT_EX extensible.
- Needed to create **textbooktools** code
 - ⇒ With new **commands** and **environments**.
- **Example:** Textbooks have **exercise blocks**
 - ⇒ With **answer appendix** at the back.
- I created an **exercise** L^AT_EX environment.
- Exercises blocks auto-numbered, formatted.
 - ⇒ Different **enumeration styles** to choose from
 - ⇒ Depending how exercises appear in document
- Author lists **problems** followed immediately by **solutions**.
- These **automatically enumerated** within text and appendix
 - ⇒ Facilitates changes to problem sets
- **Page references** to solutions auto-generated.
 - ⇒ **Hyperlinks** in electronic PDF

Sample Exercise

```
\begin{exercise}[Chain Rule]
\begin{problemblock}{Differentiate using the Chain Rule:}

\item  $f(x) = (x^8 + 2x)^{12}$ 
\answer{ $f'(x) = 12(x^8 + 2x)^{11}(8x^7 + 2)$ }

\item  $f(\theta) = \sin(\theta^2)$ 
\answer{ $f'(\theta) = 2\theta \cos(\theta^2)$ }

\end{problemblock}

\item Next question
\answer{and its answer}


- 
- (Remaining problems in here)
- 



\end{exercise}
```

L^AT_EX Challenges

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- Extensibility can **create** problems.
 - ⇒ **Newer packages** created supersede **older** ones.
 - ⇒ Results in **multiple ways** to do the same thing.
- A **best practices** guide for authors would be useful.
 - ⇒ Perhaps enforced in a **textbook document class**.
- Narrowing (and hiding) choice makes for:
 - ◆ Easier **learning**.
 - ◆ Simpler **maintenance**.
- **Accessibility?**: Can recompile to PDFs of **larger font**
 - ⇒ This must happen on **creator side** not on **user end**.
- **Port to other document formats** (ePubs, HTML, etc.)
 - ⇒ Not in original L^AT_EX design.

Markdown

- Just like creating a good **print document** (PDF)
 - ⇒ A similar challenge faces good **web documents** (HTML)
- **Markdown**: A plain text lightweight markup language
 - ⇒ For creating formatted text.
 - ⇒ Created by **John Gruber** and **Aaron Swartz** (2004)
- Useful because **by design** the **source text** is **highly readable**
 - ⇒ And consequently also **highly editable**.
- **Content** is **separated** from **layout**
 - ⇒ For the web a **cascading style sheet** (CSS) file formats the page.
- Many markdown versions (flavours) exist
 - ⇒ With different extensions (e.g. computer code blocks)
- Common one is **Github Flavoured Markdown**
 - ⇒ Used in README files for code projects.
- **Pandoc-flavoured** markdown has **more extensions** (e.g. math, footnotes.)
- A computer program is needed to **convert** to **desired output**
 - ⇒ Typically a **web document** (HTML)

Pandoc Markdown Example

```
# My first section
## An Important Subsection
```

This paragraph contains some *italic* characters as well as some characters in **bold**.

Here is a list of American presidents:

1. George Washington
1. Thomas Jefferson
2. Abraham Lincoln
3. Teddy Roosevelt

This is some inline math: $x^2 + \cos\{x\} + \pi$

This needs a footnote.^[Some footnote text.]

The following is a code block in the C programming language.

```
```c
#include <stdio.h>
int main() {
 printf("Hello, World!");
 return 0;
}
```
```

Ghostwriter Markdown Editor

```
# My first section
## An Important Subsection
```

This paragraph contains some *italic* characters as well as some characters in **bold**.

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My first section

An Important Subsection

This paragraph contains some *italic* characters as well as some characters in **bold**.

Here is a list of American presidents:

1. George Washington
2. Thomas Jefferson
3. Abraham Lincoln
4. Teddy Roosevelt

This is some inline math: $x^2 + \cos x + \pi$

This needs a footnote.¹

The following is a code block in the C programming language.

```
#include <stdio.h>
int main() {
    printf("Hello, World!");
    return 0;
}
```

-
1. Some footnote text.↩

Ghostwriter Markdown Editor

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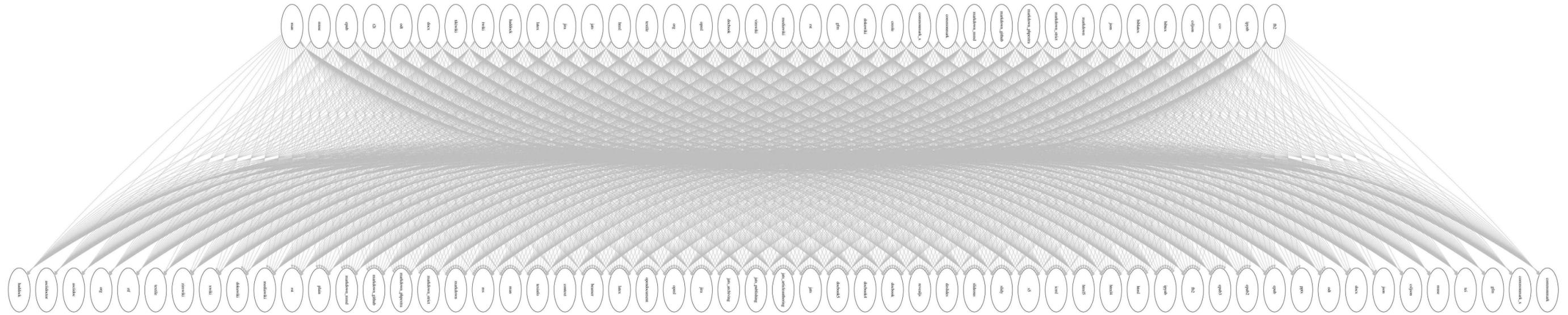
- **Markdown editors** exist to make writing Markdown **easier**
 - ⇒ **Ghostwriter** (shown) is an open source one.
- Left side displays **source text file**
 - ⇒ Editor is **context aware**
 - ⇒ Provides **highlights** to make writing easier.
 - ⇒ But these are **not** part of the code.
- Right side displays **web (HTML) output**
 - ⇒ Using Github Flavored Markdown **CSS** file.
 - ⇒ Convenient since it displays **rendered math** (using MathJax)
 - ⇒ To help **debug math entry**.
- Use **context aware** plain text editor for any project
 - ⇒ A **generic** text editor like **Emacs** knowing many contexts.
 - ⇒ Or **specialized** editors designed per format type (e.g. **Ghostwriter**)
- Plugins that show **some rendering** useful
 - ⇒ To spot **syntax errors** in source.

Pandoc

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- Ghostwriter uses Pandoc software backend to:
 - ◆ Convert **Markdown** to a **web document** (HTML):
 - ⇒ Command line: `pandoc demo.md -o demo.html`
 - ◆ Or **Markdown** to a **print document** (PDF) via L^AT_EX:
 - ⇒ Command line: `pandoc demo.md -o demo.pdf`
- What **is** Pandoc?
 - ⇒ Command line software to **convert** between document formats
 - ⇒ It converts **everything**: HTML, Word, L^AT_EX, slides, wikis, EPUBs:
- Written by **John MacFarlane**
- How Pandoc works:
 - ⇒ **Reader filter** to convert **from** document format (say Word)
 - ⇒ To an **internal representation** (Abstract Syntax Tree)
 - ⇒ **Writer filter** to convert **to** document format (say L^AT_EX)

Pandoc



- Above diagram shows **input formats** (top) and **output formats** (below)!
- **New readers and writers** can be written.
- Pandoc useful to get project **started in a different format**:
⇒ Some structure **may be lost** in translation.
- **Pandoc's Markdown** extends Markdown to support **extra features** AST represents.
⇒ `pandoc-citeproc` module allows **citation support**
⇒ So you can **write academic projects** in Pandoc Markdown.
- **L^AT_EX headers** can be used to modify **print** (PDF) layout.
- **CSS files** can be used to format **web** output.

PreTeXt

- PreTeXt is an XML-based plain-text language for textbooks and articles.
- Written by Rob Beezer.
- Text file represents **only logical structure and content**
- Various output formats possible
 - ⇒ Principle ones are web (HTML) documents
 - ⇒ And print documents (via L^AT_EX).
- Main advantages:
 - ◆ Designed for **textbooks**
 - ⇒ Necessary **structures** (example sectioning, solution etc.) built into syntax
 - ⇒ Thereby limiting need for macros.
 - ◆ Excellent **output formatting**:
 - ⇒ Makes awesome web textbook
 - ⇒ And good-looking print version (via L^AT_EX)
 - ◆ PreTeXt project has done **all the layout** heavy lifting.
 - ⇒ So, for instance **accessibility** concerns.
 - ◆ PreTeXt web versions can integrate **WeBWork problems**, **Sage entry boxes**, etc.
 - ⇒ Assuming those servers configured.

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Integrating WeBWork into Textbooks: Sample Exercises

Robert Beezer, Alex Jordan

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4 Antidifferentiation

4.1 A Few More Features

This subsection demonstrates a few more features.

Definition 4.1. Antiderivative of a Function. Suppose that $f(x)$ and $F(x)$ are two functions such that

$$F'(x) = f(x).$$

Then we say F is an **antiderivative** of f .

The Fundamental Theorem of Calculus is one of the high points of a course in single-variable calculus.

Theorem 4.2. The Fundamental Theorem of Calculus. If $f(x)$ is continuous, and the derivative of $F(x)$ is $f(x)$, then

$$\int_a^b f(x) dx = F(b) - F(a)$$

PreTeXt Minimal Example

```
<?xml version="1.0" encoding="UTF-8" ?>
```

```
<!--*****
```

```
Copyright 2016 Robert A. Beezer
```

```
*****-->
```

```
<pretext>
```

```
  <article xml:id="hello-world">
```

```
    <p>Hello, World!</p>
```

```
  </article>
```

```
</pretext>
```

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PreTeXt

- XML (eXtensible Markup Language) uses **tags** to represent structures.
⇒ Similar to HTML.
- XML aware text editor makes it less onerous.
⇒ Quick keys, auto-tag completion, visible highlighting.
- Create documents from command-line with
 - ◆ **web**: `xsltproc -o hello.html mathbook-html.xsl hello.xml`
 - ◆ **tex**: `xsltproc -o hello.tex mathbook-latex.xsl hello.xml` ⇒
Followed by `pdflatex hello.tex`.
 - ◆ **Other formats**: use corresponding `.xsl` file.

A PreTeXt Markdown?

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- Writing in XML is not for everyone
 - ⇒ May discourage others modifying your text.
- Nice if you could write in Markdown
 - ⇒ But create PreTeXt output.
- Pandoc does have a PreTeXt writer by Oscar Levin
 - ⇒ A piece of code written in Lua programming language
 - ⇒ Allows initial conversion into PreTeXt:

```
pandoc demo.md -t pretext.lua -o demo.xml
```
- But structures limited to what Pandoc internally stores
 - ⇒ No PreTeXt theorem, definition, or example sectioning.
- However...
 - ◆ Pandoc extensible with fenced divs and fenced spans
 - ⇒ Allows extra PreTeXt structure to be added to Pandoc Markdown.
 - ⇒ With suitable modification of the pretext.lua file.
 - ◆ Since divisions and spans are HTML structures
 - ⇒ These in turn can be added to markdown editor's CSS file
 - ⇒ Providing meaningful visual feedback of PreTeXt structures when writing.
- Preliminary work on a modified pretext.lua file has been done...

Using Fenced DIVs for a PreTeXt Markdown

The Exercise Section

```
::: exercises :::::::::::
::: exercise
State Einstein's fundamental equation relating energy and
mass.
:::
::: exercise
::: statement
State Plank's equation.
:::
::: hint
Think about light for a second.
:::
::: answer
 $E=h\nu$ 
:::
::: solution
The solution is more involved as it relates to blackbody
radiation.
:::
:::
```

The Theorem Section

```
::: theorem :::
::: statement
This is a theorem with no name.
:::
::: proof
The proof is in the pudding.
:::
:::
::: {.theorem #pythagoreanththeorem title="The Pythagorean
Theorem"}
::: statement
For a right triangle with legs of length  $a$  and  $b$  and
hypotenuse of length  $c$  we have
```

x^2+2x+4

Note the title appears in the ghostwriter output if you hover.

Should this really span? Maybe it should be a div like

x^2+2x+5

or

x^2+2x+6

Notice that these fail in the output due to the paragraph tags that get introduced which should not be there.

Note we need to look at what equation arrays etc. are possible.

The Exercise Section

State Einstein's fundamental equation relating energy and mass.

State Plank's equation.

Think about light for a second.

$E = h\nu$

The solution is more involved as it relates to blackbody radiation.

The Theorem Section

This is a theorem with no name.

The proof is in the pudding.

For a right triangle with legs of length a and b and hypotenuse of length c we have

$a^2 + b^2 = c^2$.

Note that in the exercises if we try to use a span rather than a div for things like statement then these fail (at least in the pdf output) due to the lack of paragraph spacing.

So paragraph tags naturally occurs with a (fenced) div. Indeed the pandoc example even says "This is the first paragraph".

This section has no title but a label!

My Section

This section has a name and an implicit label "my-section"

Boring Section

Managing Your Textbook Project

- Because \LaTeX , Markdown, and PreTeXt are **plain text**
 - ⇒ They can use **version control systems** used for computer code.
- Most commonly used is **Git** by **Linus Torvalds**.
- **Easily installed** on your own computer
- **Features:**
 - ◆ Allows elegant sharing and management of **collaborative** texts.
 - ⇒ Run a Git server
 - ⇒ Or use a corporate server like GitHub
 - ◆ Allows for textbook **branches**
 - ⇒ For parallel versions of the same textbook.
- See **Git for Authors** by Rob Beezer and David Farmer

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References

- Mittelbach, F., & Goossens, M. (2004). *The L^AT_EX companion* (2nd ed.). Boston, Massachusetts: Addison-Wesley.
- *Pandoc User's Guide*: pandoc.org/MANUAL.pdf
- See pretextbook.org/documentation.html
 - ⇒ For *The PreText Guide*
 - ⇒ And *Git for Authors*

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Software Links

Tex Live: www.tug.org/texlive

Pandoc Universal Document Converter pandoc.org

Ghostwriter Markdown Editor: wereturtle.github.io/ghostwriter

PreTeXt: pretextbook.org

Pandoc to PreTeXt writer pretext.lua github.com/oscarlevin/pandoc-pretext

Git: git-scm.com

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