UTMOST 3

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Undergraduate Teaching and Learning in Mathematics with Open Software and Textbooks

Improving Undergraduate STEM Education, Development and Implementation, Engaged Student Learning

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Educational Research Study

The goal is to better understand teacher and student use of textbooks that are available in two formats—HTML and PDF.

Methods

- Three open source electronic textbooks: active calculus (Boelkins), linear algebra (Beezer) and abstract algebra (Judson)
- Forty-nine courses at forty institutions (variation by research intensity, size, location)
- Periodic logs filled by teachers and students over the course of a semester
- Teacher and student surveys of attitudes towards mathematics and technology
- Beginning and end-of-term assessment of student growth (mathematical maturity and course content knowledge)
- In-situ visits for nine courses that included planning and classroom observations and discussion of textbook use by teachers and students
- Commentaries on analytics user data collected automatically

Analysis

- Description of generation of documents (lecture notes) and the similarities and differences between users of electronic and print formats
- Description of use of textbooks in classroom and the similarities and differences between users of electronic and print formats
- Automatic analysis of student responses to logs to differentiate uses by course and format

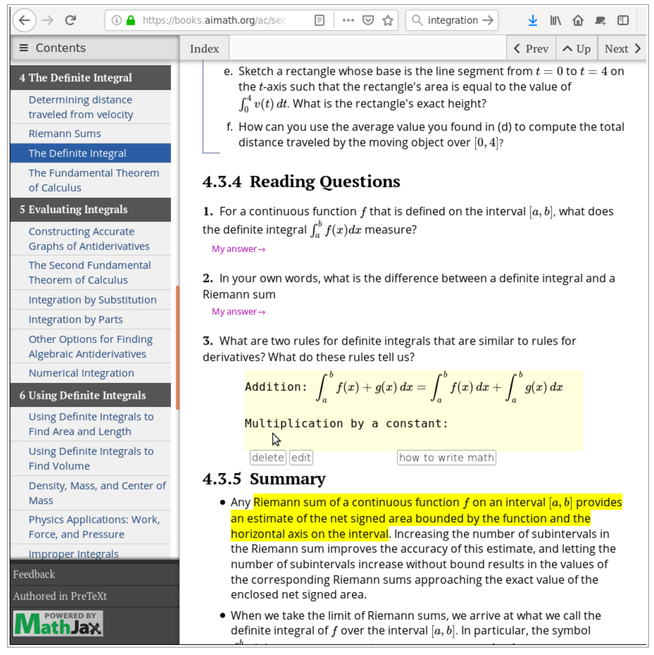
Findings—Teachers

- Use a variety of resources in generating their lecture notes
- Wide range of lesson enactment that does not seem to be related to textbook format

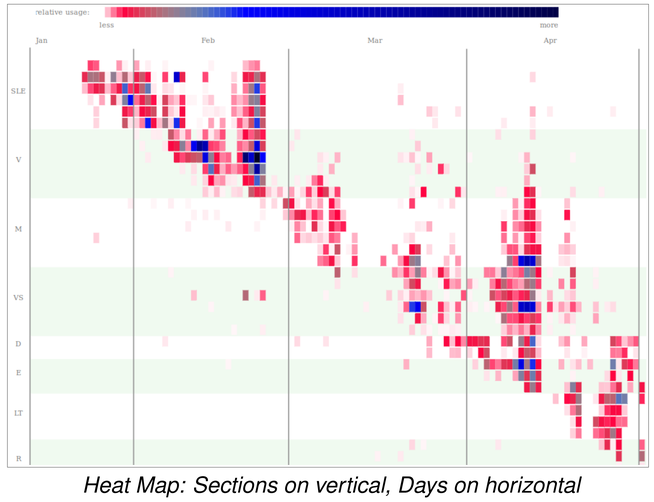
Findings—Students

- Students use a wide range of resources in addition to their textbooks: other textbooks (bound, and HTML), Internet (e.g., Wolfram, Google), instructor, classmates, peers and family
- Students' use of textbook depends on teachers' expectations of those uses: if teachers ask students to read the textbook, students will do so. If the teachers suggest using examples for solving homework, students will do so. If teachers bring new proofs, students will skip proofs in textbooks

Interactive Online PreTeXt Textbooks



Analysis of Student Textbook Use



Heat Map: Sections on vertical, Days on horizontal

PreTeXt Authoring and Publishing

- Separate structure and content from presentation
- Easily obtain multiple outputs from single source
- Simple markup with author-friendly XML, process with XSL stylesheets
- Output: Highly interactive web pages with sophisticated navigation
- Output: High quality print and PDF via LaTeX, with style options
- Output: EPUB, Jupyter notebooks (work in-progress)
- `pretextbook.org`

Embedded Sage Cells

- Sage Cell Server provides embedded computations, with zero setup
- Sage Cell Repository of examples
- `sagecell.sagemath.org`

AIM Open Textbook Initiative

- Fifty-one vetted and approved undergraduate mathematics textbooks
- Editorial Board
- Evaluation Criteria
- Author's Guide
- `aimath.org/textbooks`

Evaluation

External project evaluation provides formative and summative evaluation on processes, program events, research implementations, and participant feedback, using survey, interview, and observational data.

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