QUANTITATIVE MODELING OF UTMOST DATA
PURPOSE

Investigate relationships between:

- Teacher Behaviors
- Student Outcome
- Teacher Beliefs
- Textbook Format
- Student Behaviors
- Student Beliefs
DATA

- Spring 2017-Spring 2020
- Instructor surveys \((n = 29)\)
- Student surveys \((n = 399)\)
- Beginning and End of Term Tests \((n = 347)\)
- Integrated Postsecondary Data System (IPEDS)
- Student grades (reported by instructor) \((n = 662)\)
STRUCTURAL EQUATION MODELING

- Factor analysis on student survey found three factors:
  - Confidence with technology
  - Engagement with mathematics
  - Confidence in mathematics
- Used structural equation modeling (SEM) to investigate relationships with outcomes
- WLSMV to account for missing dependent variables
- $N = 397$
Teacher uses the book to guide solving problems

Student/Book Variable:
B1) Uses textbook features and tools
B2) Uses textbook to complement lecture
B3) Uses textbook features related to problems

Course Grade

Mathematical Engagement

Mathematical Confidence

B1) .973
B2) .985
B3) .963

B1) -.963
B2) .979
B3) -.952
## FIT STATISTICS

<table>
<thead>
<tr>
<th>Model</th>
<th>RMSEA ≤ .05</th>
<th>Chi-Square Value</th>
<th>CFI ≥ .95</th>
<th>TLI ≥ .95</th>
<th>SRMR &lt;0.06</th>
<th>% Variance in Course Grade Explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.043</td>
<td>127.243*</td>
<td>0.989</td>
<td>0.987</td>
<td>0.041</td>
<td>16%</td>
</tr>
<tr>
<td>B1</td>
<td>0.091</td>
<td>326.855*</td>
<td>0.953</td>
<td>0.944</td>
<td>0.493</td>
<td>93%</td>
</tr>
<tr>
<td>B2</td>
<td>0.090</td>
<td>319.125*</td>
<td>0.954</td>
<td>0.945</td>
<td>0.879</td>
<td>96%</td>
</tr>
<tr>
<td>B3</td>
<td>0.085</td>
<td>297.301*</td>
<td>0.958</td>
<td>0.950</td>
<td>0.378</td>
<td>91%</td>
</tr>
</tbody>
</table>

Cutoff values from Hu & Bentler (1999)
THINGS WE TRIED BUT DIDN’T WORK OUT

- Improved test score as outcome variable
- Controlling for major
- Activities during book use (e.g. taking notes)
- Book features used
- Instructors’ beliefs about student learning
- Administrative and department support for instructors’ use of technology
STUDENTS WHO COMPLETED THE SURVEY AND HAD GRADE DATA ($N = 377$)

<table>
<thead>
<tr>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race/Ethnicity: White</td>
</tr>
<tr>
<td>Race/Ethnicity: BIPOC (Black, Indigenous, Person of Color)</td>
</tr>
<tr>
<td>Race/Ethnicity: Asian</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Major: Math</td>
</tr>
<tr>
<td>Major: Science, Technology, Engineering</td>
</tr>
<tr>
<td>Major: Other</td>
</tr>
</tbody>
</table>

Note: Percentages of students who did not report this information are not included for brevity’s sake, so frequencies may not add up to 100 within categories (e.g., race/ethnicity).

T-tests of student grades indicate that students who completed the survey may not be representative of UTMOST students.
MULTILEVEL MODEL WITH CROSS-LEVEL INTERACTIONS

**Level 3:** Institution control, size, and selectivity

**Level 2:** Teacher, Course, and Term

**Level 1:** Student and Textbook Format Used
MULTILEVEL MODEL EQUATION

\[\text{course grade}_{ijk} = \gamma_{000} + \gamma_{100}(X_{1ijk}) + \gamma_{200}(X_{2ijk}) + \gamma_{300}(X_{1ijk})(X_{2ijk}) + \gamma_{010}(V_{1jk}) + \gamma_{020}(V_{2jk}) + \gamma_{001}(Z_{1k}) + \gamma_{002}(Z_{2k}) + \gamma_{003}(Z_{3k}) + \gamma_{004}(Z_{1k})(X_{2ijk}) + e_{ijk} + r_{0jk} + u_{k}\]

\[X_1 = \text{survey participant}\]
\[X_2 = \text{used HTML textbook}\]
\[V_1 = \text{course (e.g., abstract algebra)}\]
\[V_2 = \text{instructor typically used book during class in past classes}\]
\[Z_1 = \text{institution selectivity}\]
\[Z_2 = \text{institution size}\]
\[Z_3 = \text{institution control}\]
## Multilevel Regression, N = 662

<table>
<thead>
<tr>
<th></th>
<th>Course Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1 - Student Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Student Survey Participant</td>
<td>0.592***</td>
</tr>
<tr>
<td>Used HTML Textbook (vs. PDF)</td>
<td>0.718*</td>
</tr>
<tr>
<td><strong>Level 2 – Instructor/Term Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Course: Calculus [reference category]</td>
<td>--</td>
</tr>
<tr>
<td>Course: Abstract Algebra</td>
<td>0.520</td>
</tr>
<tr>
<td>Course: Linear Algebra</td>
<td>0.556*</td>
</tr>
<tr>
<td>Instructor Typically Used Book During Class in Past Classes</td>
<td>-0.051</td>
</tr>
<tr>
<td><strong>Level 3 – Institution Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Selectivity: Percent Admitted</td>
<td>2.390***</td>
</tr>
<tr>
<td>Private Institution (vs. Public)</td>
<td>1.024**</td>
</tr>
<tr>
<td>Size (Undergraduate Enrollment)</td>
<td>0.000*</td>
</tr>
<tr>
<td><strong>Cross-level Interactions</strong></td>
<td></td>
</tr>
<tr>
<td>Used HTML Textbook and Survey Participant</td>
<td>-0.428*</td>
</tr>
<tr>
<td>Used HTML Textbook and Percent Admitted</td>
<td>3.380†</td>
</tr>
</tbody>
</table>

*** p<0.001, ** p<0.01, * p<0.05, † p<0.10
The student survey beliefs and attitudes scale can be used to make valid inferences for this sample.

Students may benefit from using a HTML textbook, particularly if they attend a less-selective institution.

Students who complete the survey are not representative of the UTMOST student population.

Instructor, classroom/peer, and institution characteristics matter.
UTMOST 3.0

THANK YOU!

Collaborators:

- Rob Beezer (University of Puget Sound)
- Tom Judson (Stephen F. Austin State University)
- David Farmer (American Institute of Mathematics)
- Kent Morrison (American Institute of Mathematics)
- Megan Littrell (University of Colorado at Boulder)
- Vilma Mesa, Claire Boeck, Saba Gerami, Palash Kanwar,
- Julia Maxwell, Mina Nielsen, Carlos Quiroz, and Lynn Chamberlain (University of Michigan)

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