

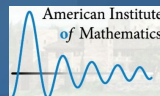
Undergraduate Teaching and Learning of Mathematics with Open Source Textbooks
Participant Workshop

Claire Boeck, June 18, 2021

QUANTITATIVE MODELING OF UTMOST DATA



SCHOOL OF
EDUCATION
UNIVERSITY OF MICHIGAN



PURPOSE

Investigate relationships between:

Teacher
Behaviors

Student
Outcome

Teacher
Beliefs

Student
Beliefs

Student
Behaviors

Textbook
Format

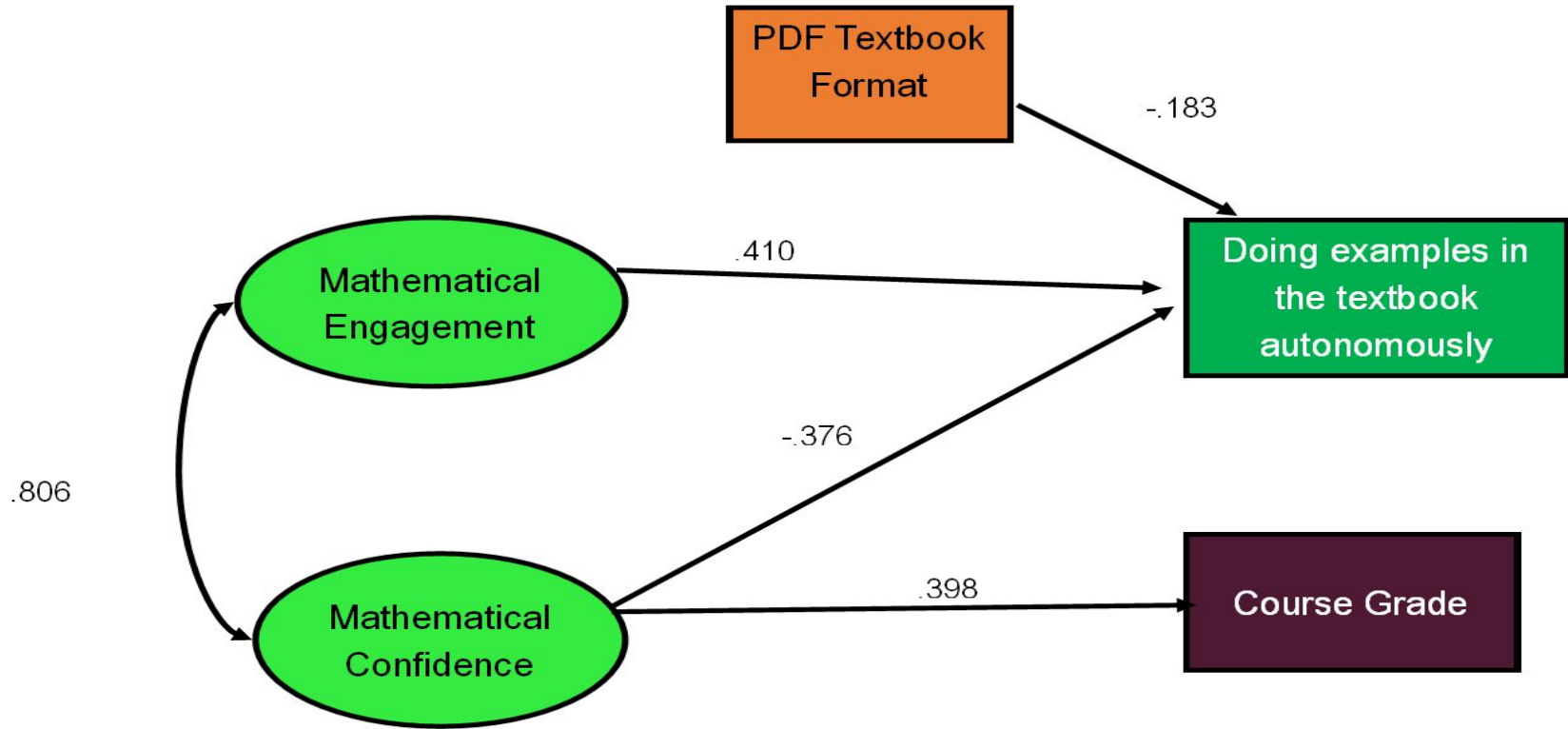
DATA

- 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) ($n = 662$)

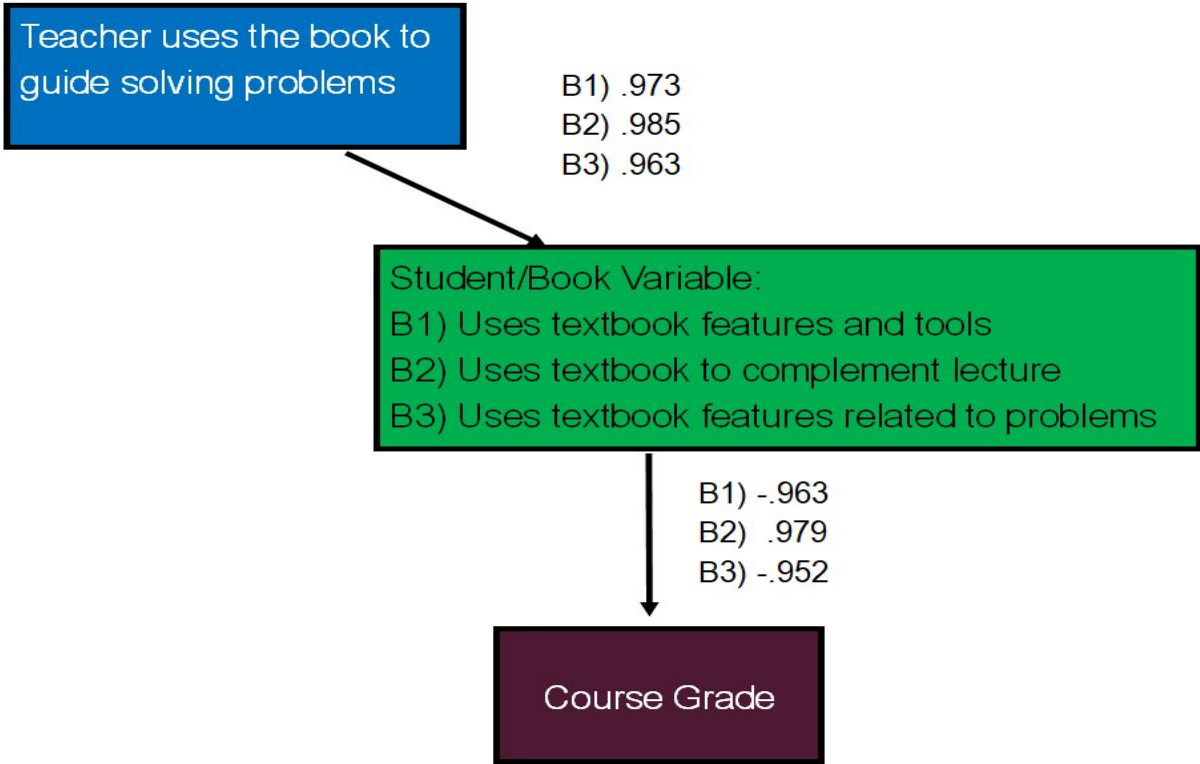
STRUCTURAL EQUATION MODELING

- 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
- $N = 397$

MODEL A



MODEL B SERIES



FIT STATISTICS

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

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 ($N = 377$)

Percentage of Students

Race/Ethnicity: White	51%
Race/Ethnicity: BIPOC (Black, Indigenous, Person of Color)	22%
Race/Ethnicity: Asian	8%
Female	42%
Major: Math	35%
Major: Science, Technology, Engineering	31%
Major: Other	24%

T-tests of student grades indicate that students who completed the survey may not be representative of UTMOST students.

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).

MULTILEVEL MODEL WITH CROSS-LEVEL INTERACTIONS

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

Institution



Book
Format

Level 2: *Teacher, Course, and Term*

Section 100

Section 200

Section 300

Student 101

Student 201

Student 301

Student 102

Student 202

Student 302

Student 103

Student 203

Student 303

Student 104

Student 204

Student 304

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 = survey participant

X_2 = used HTML textbook

V_1 = course (e.g., abstract algebra)

V_2 = instructor typically used book during class in past classes

Z_1 = institution selectivity

Z_2 = institution size

Z_3 = institution control

MULTILEVEL REGRESSION, $N = 662$

Course Grade

Level 1 - Student Variables

Student Survey Participant

0.592***

Used HTML Textbook (vs. PDF)

0.718*

Level 2 – Instructor/Term Variables

Course: Calculus [reference category]

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Course: Abstract Algebra

0.520

Course: Linear Algebra

0.556*

Instructor Typically Used Book During Class in Past Classes

-0.051

Level 3 – Institution Variables

Selectivity: Percent Admitted

2.390***

Private Institution (vs. Public)

1.024**

Size (Undergraduate Enrollment)

0.000*

Cross-level Interactions

Used HTML Textbook and Survey Participant

-0.428+

Used HTML Textbook and Percent Admitted

3.380+

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$

SUMMARY

- 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!

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