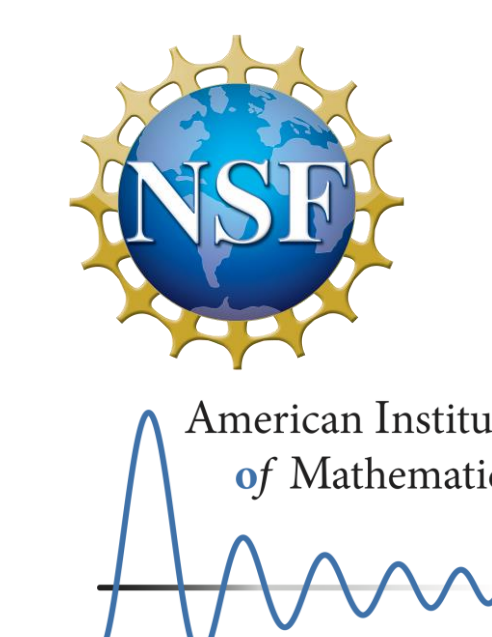


How do Students Engage with Their Math Textbooks? Development of a Qualitative Instrument to Analyze Students' Responses About Textbook Use

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Abstract

Online textbooks are beneficial because of their accessibility. In this research, we would like to know how this new format of textbooks affects teachers' teaching and students' learning of mathematics. We collect data from students' reported usage of three online textbooks and their responses to weekly survey questions. In order to analyze the responses, we develop an instrument that assisted the researchers in performing thematic analysis. We are currently developing a new version of the coding scheme that can help the research team to identify the trend in the data and make summaries of students' responses. Future endeavors will need to refine the instrument aiming to further adaptation and use in other contexts.

Background and Context

We are interested in how online textbooks affect the teaching and learning of teachers and students in mathematics. This new format of textbook has features like Sage cells (which allow students to make computations) and links that show and hide relevant information as needed.

In Figure 1, the resources represent the new textbooks. We are interested in the connection between the resources to the teacher, student and mathematics.

The textbooks are written in PreTeXt which allows us to follow and track the work of each student. The instructors may use this information to improve teaching and learning in the class. These textbooks can be accessed online, which reduces the need for a physical textbook; they are also free to students.

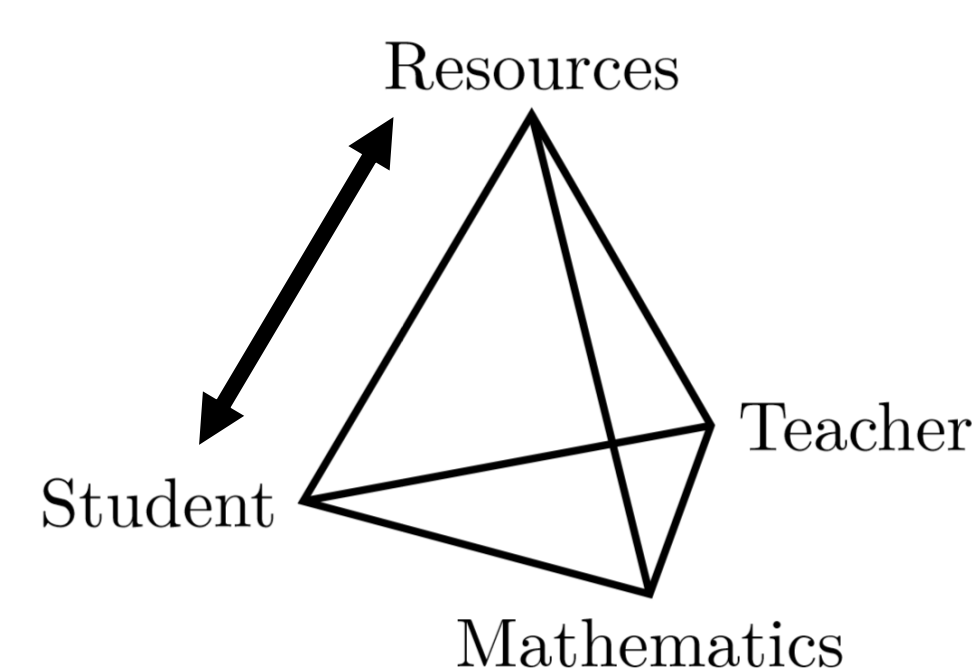


Fig 1: Socio-didactical tetrahedron. Adapted from [4].

Methods

After getting the data from the survey, we first match the IDs with to see if some of the data was missing or misplaced. Then we cleaned the records by looking for repeated responses. To demonstrate the coding procedure, in this poster, we use 344 students' responses to question "What do you do while reading your textbook?"

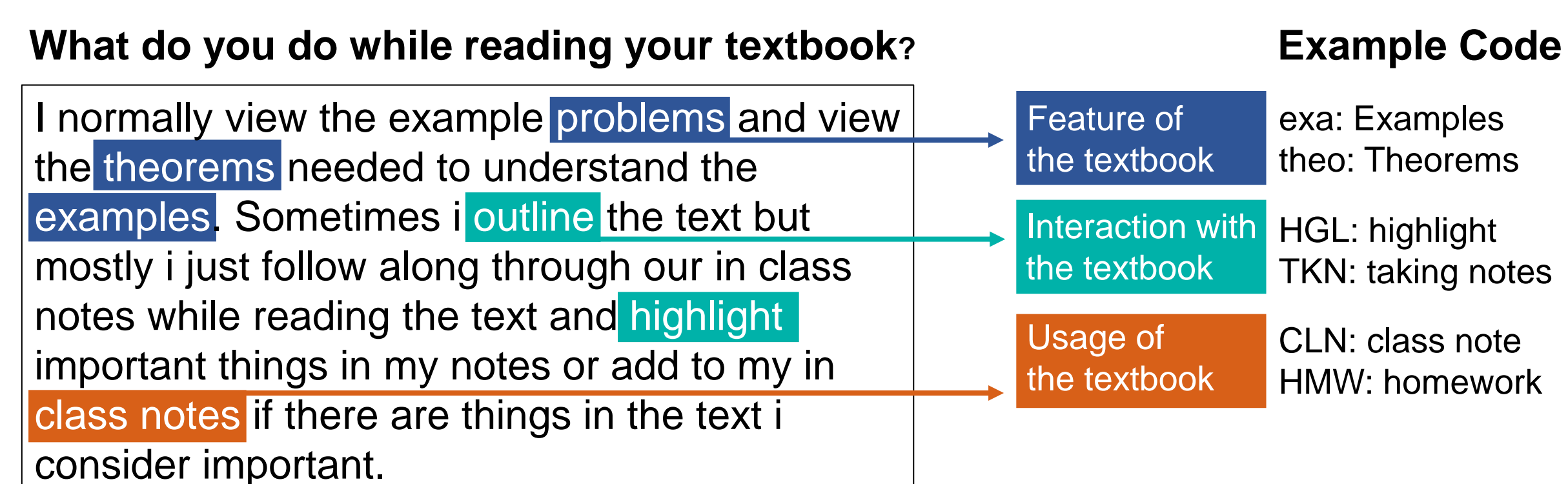


Fig 2: Coding process.

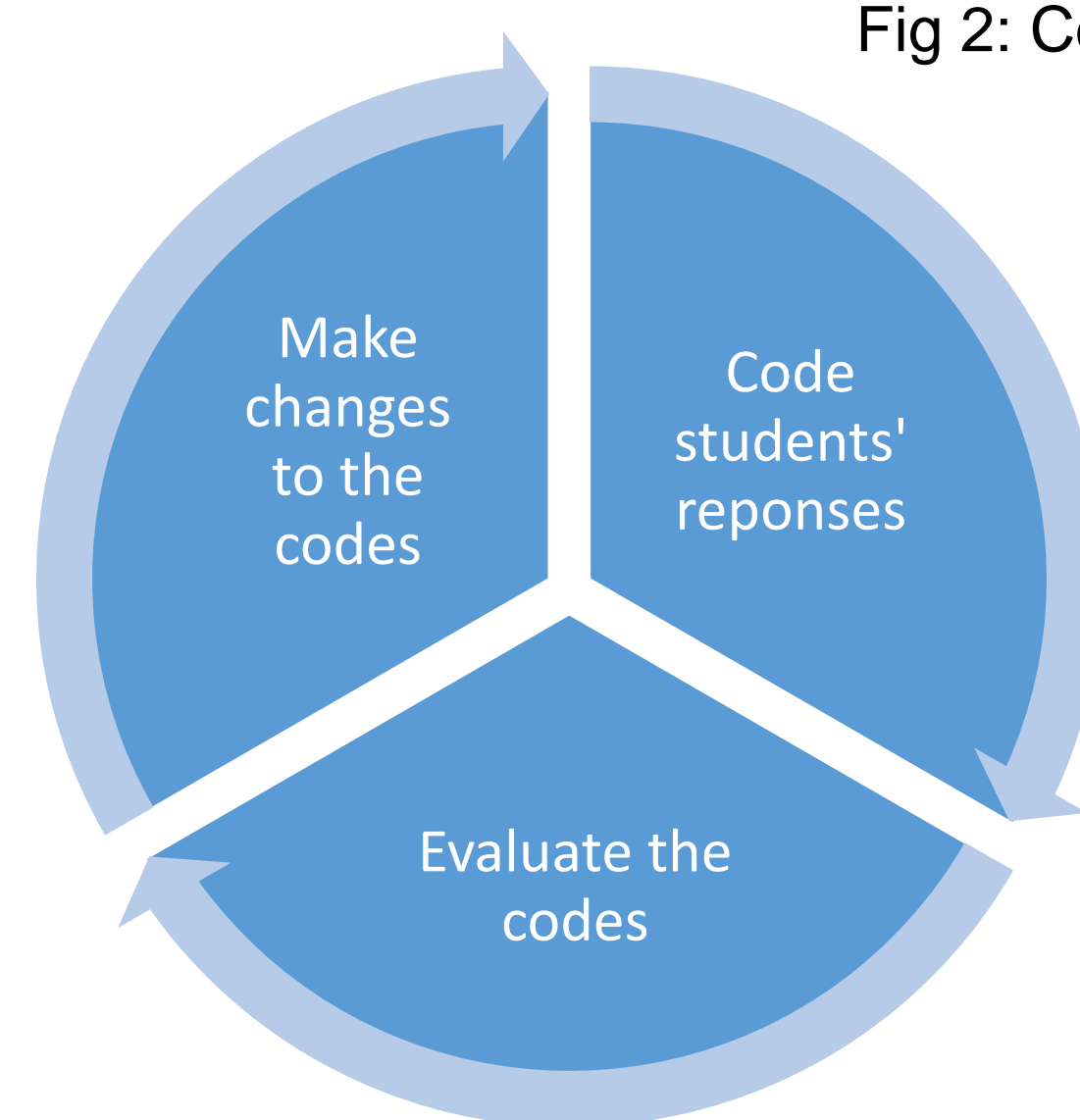


Fig 3: Code developing process.

A codebook was given to each coder. The coders read the responses and assigned a code to it. The coding was used to find recurring patterns of textbook use. After the coding was done, the information was used for writing a summary of all the responses. The summary will be used in later steps of the research. By looking at the frequency of each code, we found the pattern in students' response.

In Figure 4, we can see some changes to the code between the old and the new version. We grouped the evaluation codes together and add the codes for appraisals to better describe the students' evaluation. The code "strategy to study" and "use of textbook" did not provide us enough information about students' textbook use and were replaced with other codes.

Old version	New version
Negative Evaluation	Negative Evaluation
Positive Evaluation	Positive Evaluation
Negative Navigation	Codes for appraisals
Positive Navigation	
Conceptual Browsing	Conceptual Browsing
Strategy to Study	General Learning Content Seeking Help
Using class' notes	Complementing Lectures
Use of Textbook	Before Class Preparation
	During Class Use
	Quiz Exam Preparation

Fig 4: Changes between old version and new version of code

Expected Outcome

I used the frequency of each code to see trends in the student's responses and to write a summary. For example, I can see that most students mention examples in their responses, follow by theorems, definitions, exercises and reading questions (see Figure 5).

When I coded some of the responses, I found that some responses had information that can be inferred to but not explicitly stated in words, while some responses were ambiguous in the description on what the student was doing.

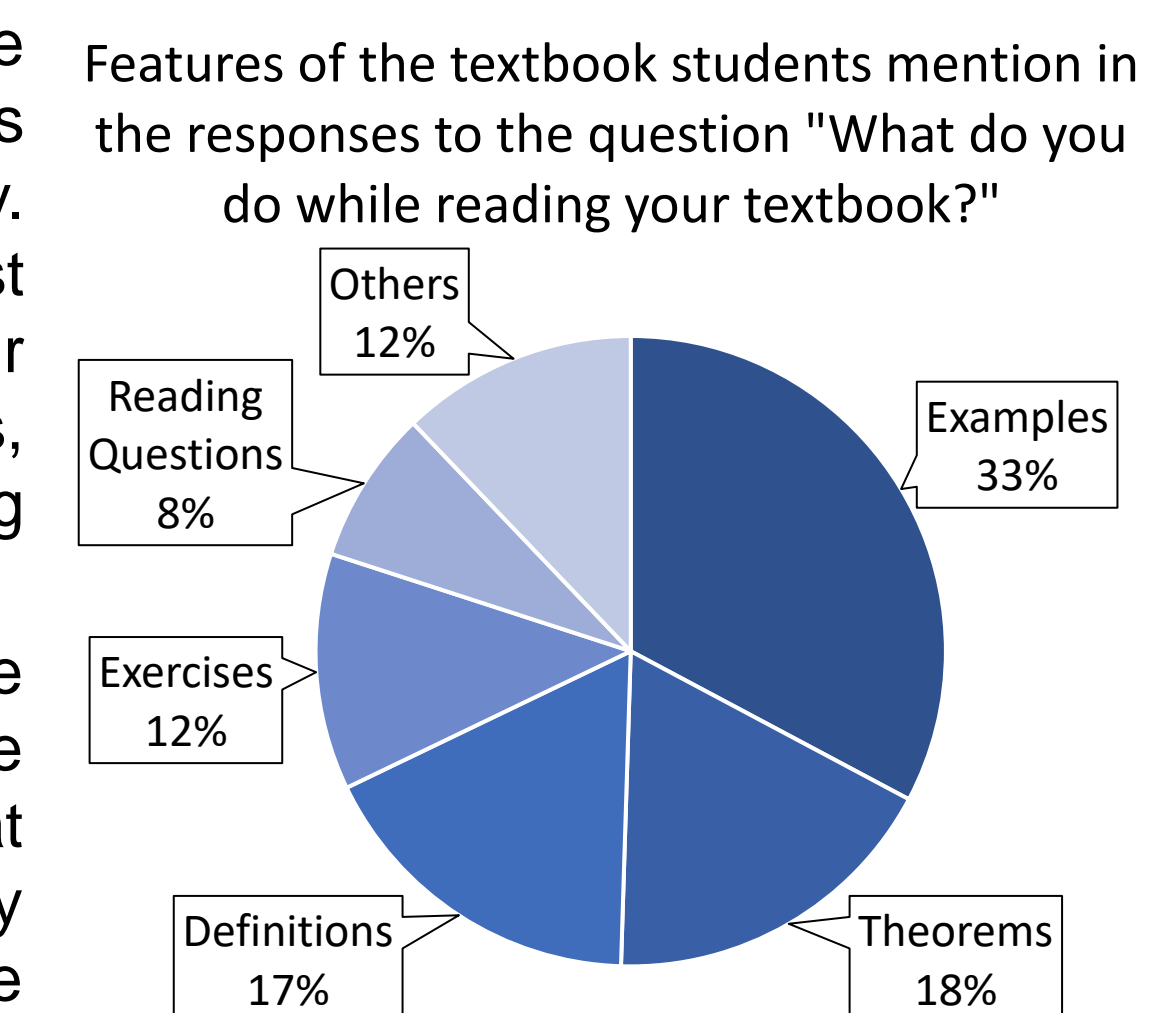


Fig 5: Frequency of features of textbooks mentioned by students in responses to the question "What do you do while reading your textbook?"

Implication and Discussion

This process contributes to developing the natural language algorithm to extract the information from a much larger set of the responses to other questions. The process runs in cycle; after we get this new version of the code, we individually code the response according to this new version and compare them with each other. We would like to create the algorithm that can systematically extract the information from the responses.

The code that we create will be applied to other questions in bi-weekly logs. Moreover, this new algorithm might be able to apply to responses from other contexts.

From this project, I learn about the process of qualitative research and coding instrument. I acknowledge that there is the need for the human to read the responses in order to develop the tools to analyze them.

Acknowledgements

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References

- [1] Beezer, R. (2019). First course in linear algebra. Gig Harbour, WA: Congruent Press. Available at <https://books.aimath.org/>.
- [2] Boelkins, M. (2018). Active Calculus. Available at <https://activecalculus.org/single/>: CreateSpace Independent Publishing Platform.
- [3] Judson, T. (2017). Abstract algebra: Theory and applications. Available at <http://abstract.pugetsound.edu>. HTML available at <http://abstract.ups.edu/aata/>. Orthogonal Publishing L3
- [4] Rezat, S., & Strässer, R. (2012). From the didactical triangle to the socio-didactical tetrahedron: Artifacts as fundamental constituents of the didactical situation. *ZDM Mathematics Education*, 44, 641-651. doi:10.1007/s11858-012-0448-4

Active Calculus



<https://activecalculus.org/single/frontmatter.html>

First Course in Linear Algebra



<http://linear.ups.edu/html/fcla.html>

Abstract algebra



<http://abstract.ups.edu/aata/aata.html>

In this study, we ask the question: "What do students do when they are using their textbooks?" The large study will recruit 49 undergraduate mathematics courses from different universities across the United States. The data used in this poster came from the bi-weekly student logs of the textbook usage and a student survey in the 2018-2019 academic year. We would like to know how this new format of the textbook is differently by students compared to the printed textbook.