

# A Digital Book Based Pedagogy to Improve Course Accessibility for Students with and without Disabilities in Engineering and other STEM courses

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## THE PROJECT

This project (GIANT2021-03) presents i) Findings from a survey that assesses the preferences and needs expressed by students with disabilities (SWD), students without disabilities (SWOD), and faculty in relation to textbooks and printed course materials and ii) New functionalities created to improve equity by supporting accessible digital book creation.

## BACKGROUND

### Accessibility of Course Content

- 65% of students surveyed reported skipping buying a textbook because of cost
- 90% of the respondents who reported skipping buying a textbook were still very concerned that not purchasing materials will negatively impact their grade
- 79% of students reported being impacted by the pandemic, which has exacerbated existing accessibility challenges

### Universal Design for Learning (UDL)

The three core practices of UDL are:

- Multiple modes of content delivery
- Multiple ways of expressing learning
- Students being engaged and motivated to learn in multiple ways

### Adoption of ClassTranscribe in Engineering Education

ClassTranscribe is a new accessible video platform based on UDL principles, to provide students with multiple pathways to access video content.

With ClassTranscribe students can:

- View recorded live content asynchronously
- Read the captions and live transcriptions
- Read transcriptions in alternative languages
- Search for relevant content across an entire course

### Digital Books

- Provide a compelling, text-based alternative to live and recorded lectures.
- Offer improved accessibility and features over traditional printed textbooks.
- Can be generated automatically using ClassTranscribe (in pdf, EPUB, and web page formats).

## METHOD

### The Survey

We adopted six of nine factors from the Collegiate Student Assessment of Textbooks (CSAT) survey to identify which factors students and faculty desire most in textbooks:

- Practical application to student's lives and convenience
- Accessibility
- Graphs and tables
- Study aid use
- Instructor use of the textbook
- Ease of use

Integer values 1-5 were assigned to the responses to the Likert questions. The questions were on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

### Demographics

The survey included respondents (N=78) from 46 STEM and engineering courses. The responses were further divided into two subgroups: SWD (n=26) and SWOD (n=38) with the ultimate aim of creating inclusive and equitable educational resources where all students can thrive,

Faculty	Student	SWD	SWOD	Undisclosed	Male	Female	Undisclosed	Mental SWD	Female SWD	Total
10	68	26	38	4	28	34	6	21	16	78
12.82%	87.18%	38.24%	55.88%	5.88%	41.18%	50.00%	8.82%	30.88%	23.53%	100.00%

### Data Analysis

The following analysis was performed without personal identified information:

- Cronbach's alpha to check consistency
- Mann-Whitney U tests to find the inter-group differences between SWD and SWOD and between female and male
- False discovery rate (FDR) controlling procedure to correct for multiple comparisons

## RESULTS

### Top-ranked textbook features for all students and faculty

Ranking	Question	Mean	Median	STDV	Positive rates
1	There is a search feature for the book.	4.48	5.0	0.819	89.7%
2	The book is low-cost or free.	4.42	5.0	0.982	82.3%
3	The examples used in the book are relevant.	4.39	5.0	0.756	86.7%
4	The examples used in the book really match the definitions provided.	4.39	5.0	0.813	82.3%
5	There is a searchable interface.	4.36	5.0	0.862	83.8%
6	Concrete examples are used to help me understand and remember.	4.35	5.0	0.842	83.8%
7	The book is up to date.	4.35	5.0	1.00	80.8%
8	The book is accessible online as well as a print copy.	4.30	5.0	1.05	82.3%
9	Core ideas are presented.	4.27	5.0	0.878	80.8%

For each of these features, more than half of the students considered it a top feature and more than 80% of the students considered it positively.

### Differences between SWD and SWOD

Question	Mean SWD	Mean SWOD	Median SWD	Median SWOD	Positive SWD	Positive SWOD	p-value	FDR p-value
In-class activities involve concepts in the book.	2.65	3.66	2.5	4.0	30.8%	57.9%	0.004	0.14
There are lots of tables in the book.	2.92	3.61	3.0	4.0	26.9%	52.6%	0.010	0.14
Ideas and examples in the textbook connect to earlier sections.	3.54	4.16	4.0	4.0	53.8%	73.7%	0.012	0.14
The examples used in the book are relevant.	4.15	4.58	4.0	5.0	84.6%	89.5%	0.015	0.14
An instructor lectures follow the book.	3.192	3.79	3.0	4.0	42.3%	65.8%	0.032	0.23

These findings suggest that **some SWD may have disabilities that prevented them from benefiting from in-class activities**, while others who used a screen reader **did not benefit from a lot of tabular data**. Without additional research these interpretations are conjectures; other interpretations are possible.

Factor	Mean SWD	Mean SWOD	Median SWD	Median SWOD	Positive SWD	Positive SWOD	FDR p-value
Instructor Use	2.782	3.439	3.0	3.0	35.3%	48.7%	<0.001
Graph	2.942	3.560	3.0	3.0	26.9%	49.3%	<0.004
Practical	3.874	4.074	4.0	4.0	67.8%	69.6%	0.06
Ease	4.038	4.150	4.0	4.0	73.6%	77.1%	0.16
Accessibility	4.077	3.932	5.0	4.0	74.6%	66.8%	0.16
Study_Aid	3.410	3.608	3.0	4.0	49.4%	54.6%	0.23

- SWD care most about **accessibility, ease of use, and practical applications/convenience**.
- SWD have significantly different opinions about instructor use of the book ( $p < 0.001$ , FDR  $p < 0.001$ ) and the use of graphs and tables ( $p < 0.002$ , FDR  $p < 0.004$ ) than SWOD.
- The factor of how the instructor uses the book seems to be the least important to all students, particularly for SWDs.

### Differences between male and female students

The major difference was that **female students had significantly lower preference to "an instructor calls on students in class with questions from the book material"** than male ( $p < 0.002$ , FDR  $p < 0.039$ , 11.8% female vs 28.6% male).

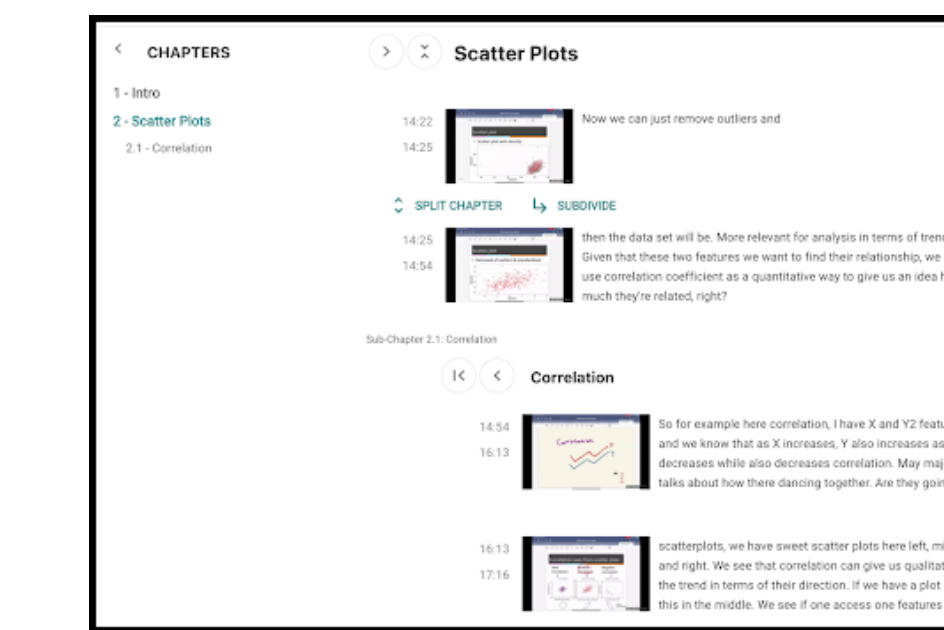
The analysis at the textbook factor level revealed female students were significantly **less interested in the instructor use of the book** ( $p < 0.0002$ ) and female students were **less interested in graphs and tables** ( $p < 0.01$ ).

## ACKNOWLEDGEMENTS

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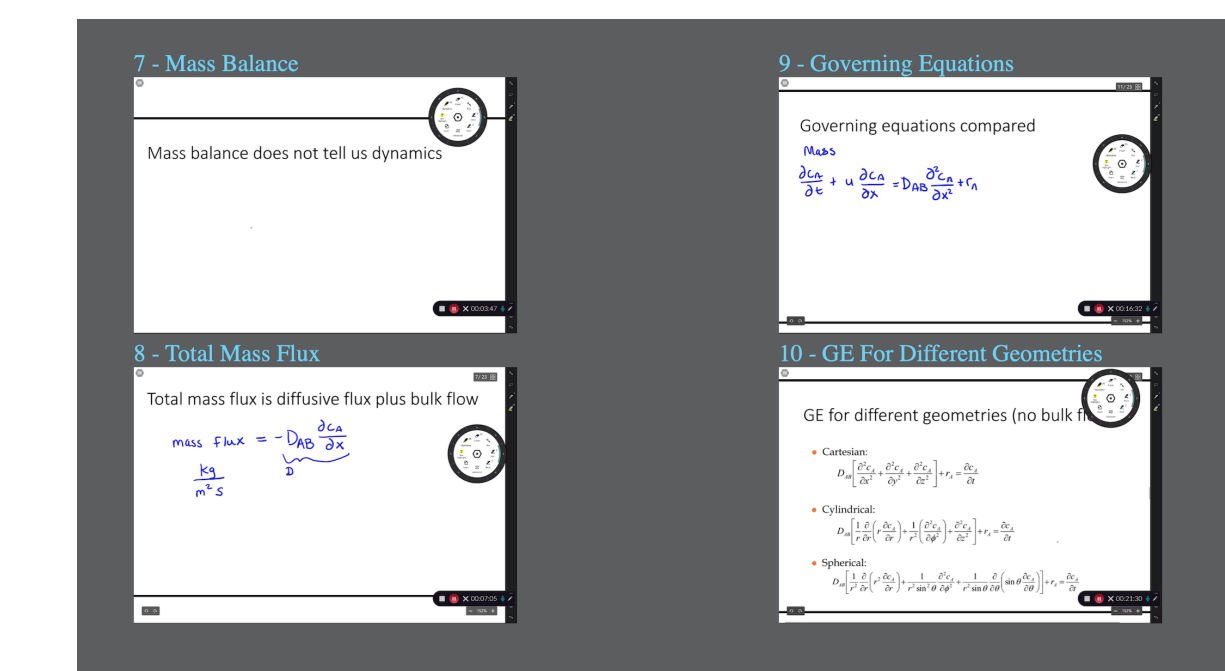
## DIGITAL BOOK CREATION

**Creating Digital Books from Lecture Videos.** We created a system to automatically convert a recorded video into a digital book that includes the presented content and the spoken transcript. Creation of the book includes several automated steps, a **simple web-based editing interface** and code to automatically assemble the book into the desired output format.



### New Visual Table of Contents

Books now include a generated visual table of contents of chapter images with each image hyperlinked to the corresponding chapter contents.



### New PDF Accessibility Tags

- All of our digital books can also be outputted in the PDF format.
- To make it accessible for SWDs, accessibility tags were added to enable rapid navigation.

## CONCLUSION

Students prefer textbooks that are **searchable, low cost, relevant, have concrete examples, and have both digital and printed options**.

Using these results and the principles of UDL, new features were designed and added to ClassTranscribe to create valuable **digital books from videos**.

### Rethinking Books

As we continue to develop features for digital book development, we look forward to better understanding how these features lead to success for all students and can improve equity for students with disabilities.

### Future Work

- Develop conditional publishing features.
- Work with students who are blind or have impaired vision to optimize file accessibility.
- Use a learning analytics approach to correlate textbook use and student performance.

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