Reading and animation usage analytics for an interactive material and energy balances textbook

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Booth 546

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zyBooks

Disclaimer: I may financially benefit from sales of the book discussed in this talk

University of Toledo IRB protocol 201808

Three hypotheses

1. Engineers are data driven
2. Students read textbooks
3. Students can use a textbook for repetition

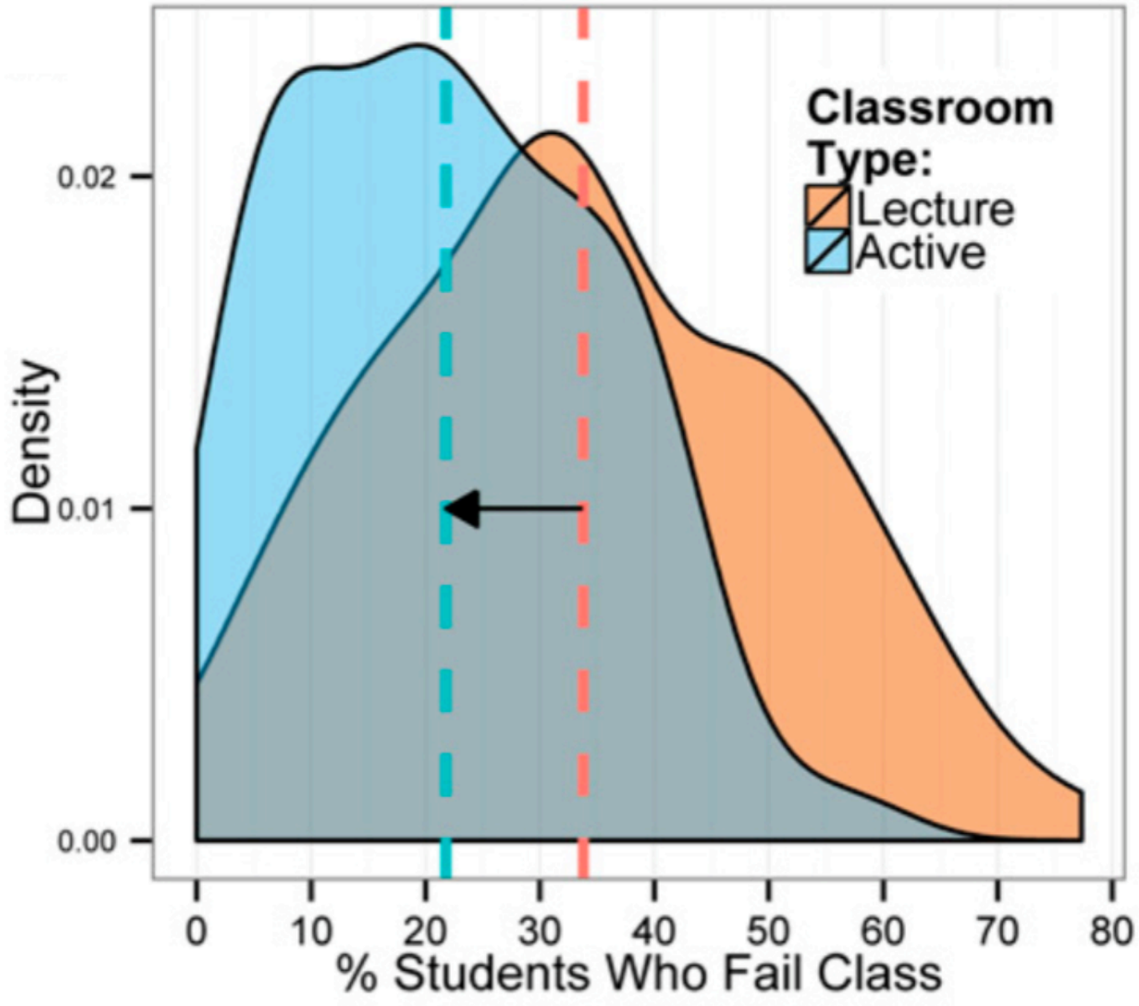
Data drives decision making

Transparent data can improve learning

Passive or active classroom

Active learning is a set of techniques where students are actively participating

Single studies
and
meta-analyses show
improved learning



Freeman, et al., PNAS, 2014. **111**(23): p. 8410-8415.

Interactive technology beneficial

Internet >> Textbook

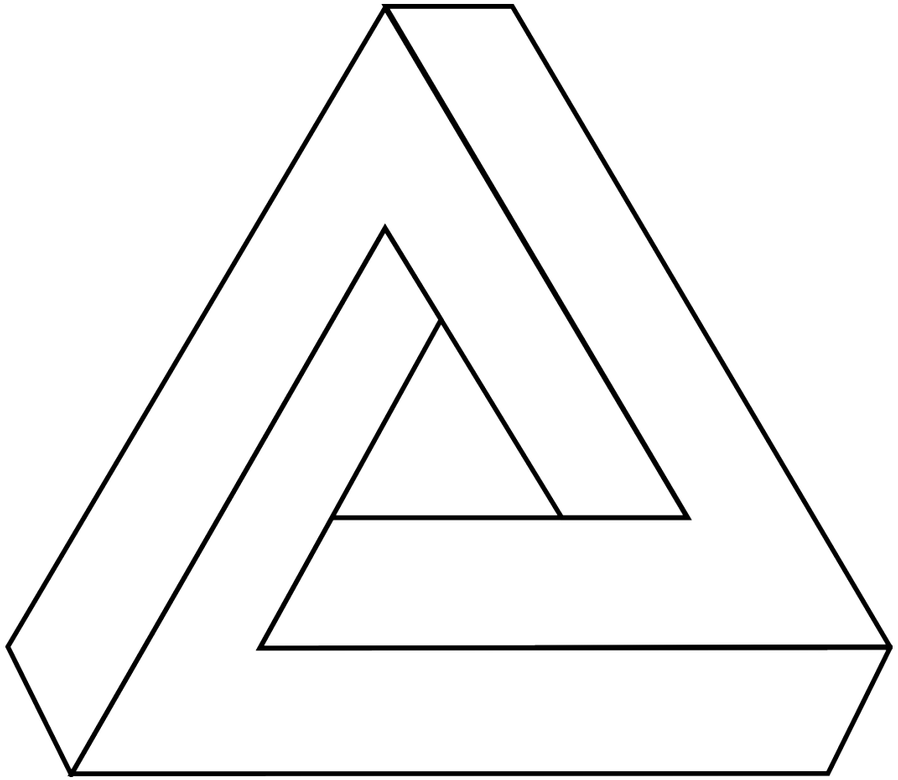
Interactive web-native > static web

Students want interactive book

References listed in proceedings paper

A common theme in engineering education

Technology



Active learning

Textbook

What is zyBooks?

Over 150,000 students

Started by Computer Science faculty in 2012

Fully interactive books

Comprehensive feedback to student and instructor

Less text, more action™

Features of a zyBook

Definitions

Learning questions

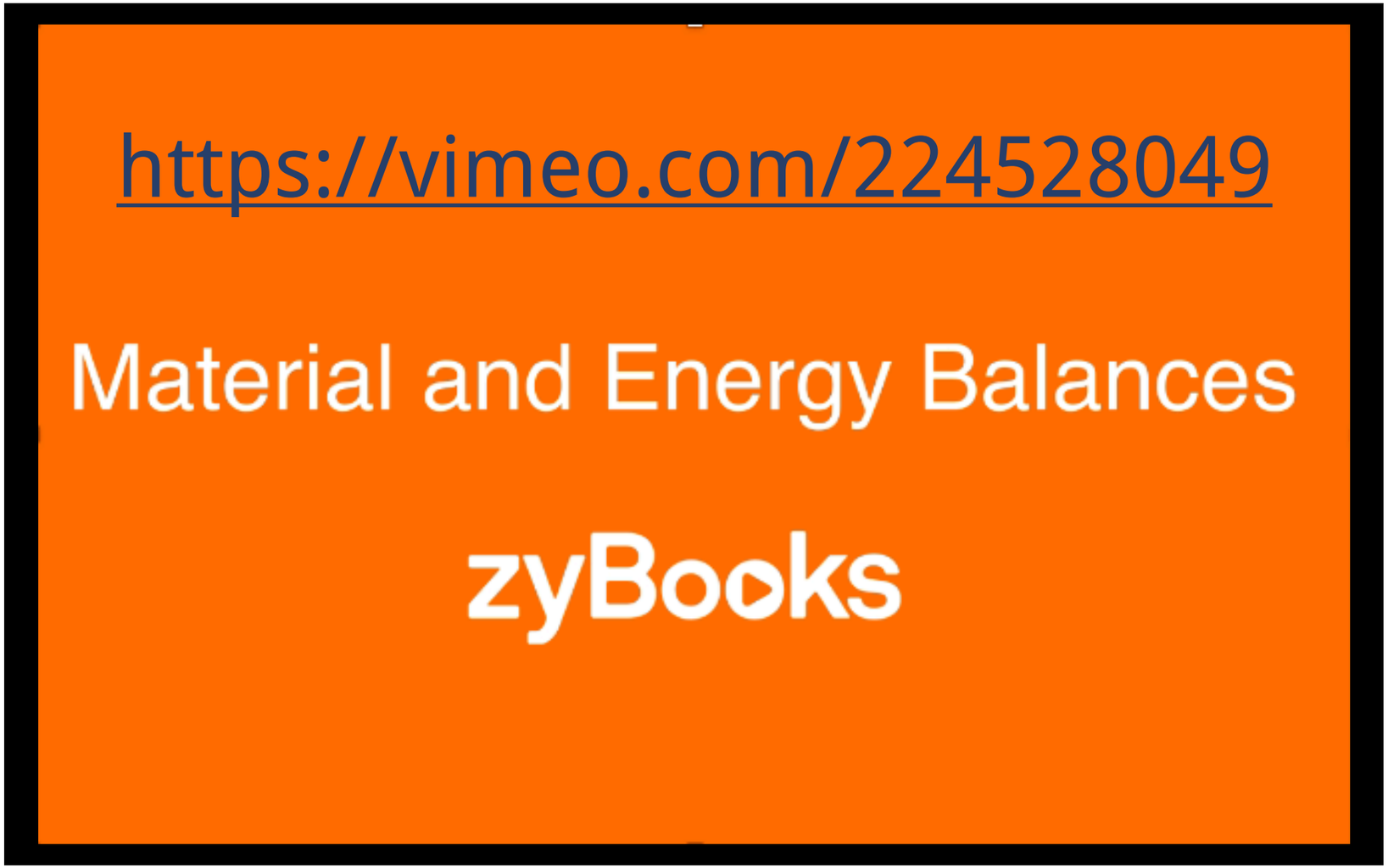
Animations

Challenge activities

Links

Data

Looking into the MEB zyBook



Less text, more action™

Over 170 auto-graded questions

Find the unknown stoichiometric coefficients for the following reaction.

$$1.6CH_4 + fO_2 \rightarrow hCO_2 + jH_2O$$

f = 1.0

h = 1.1

j = 1.2

Large number of variations per question

Over 170 auto-graded questions

Find the unknown stoichiometric coefficients for the following reaction.

$$1.6C_2H_6 + fO_2 \rightarrow gCO_2 + iH_2O$$

f = 1.0

g = 1.1

i = 1.2

Personalized with changing content, numbers

Student generate new Q with click

Find the unknown stoichiometric coefficients for the following reaction.

$$1.4C_3H_8 + fO_2 \rightarrow gCO_2 + iH_2O$$

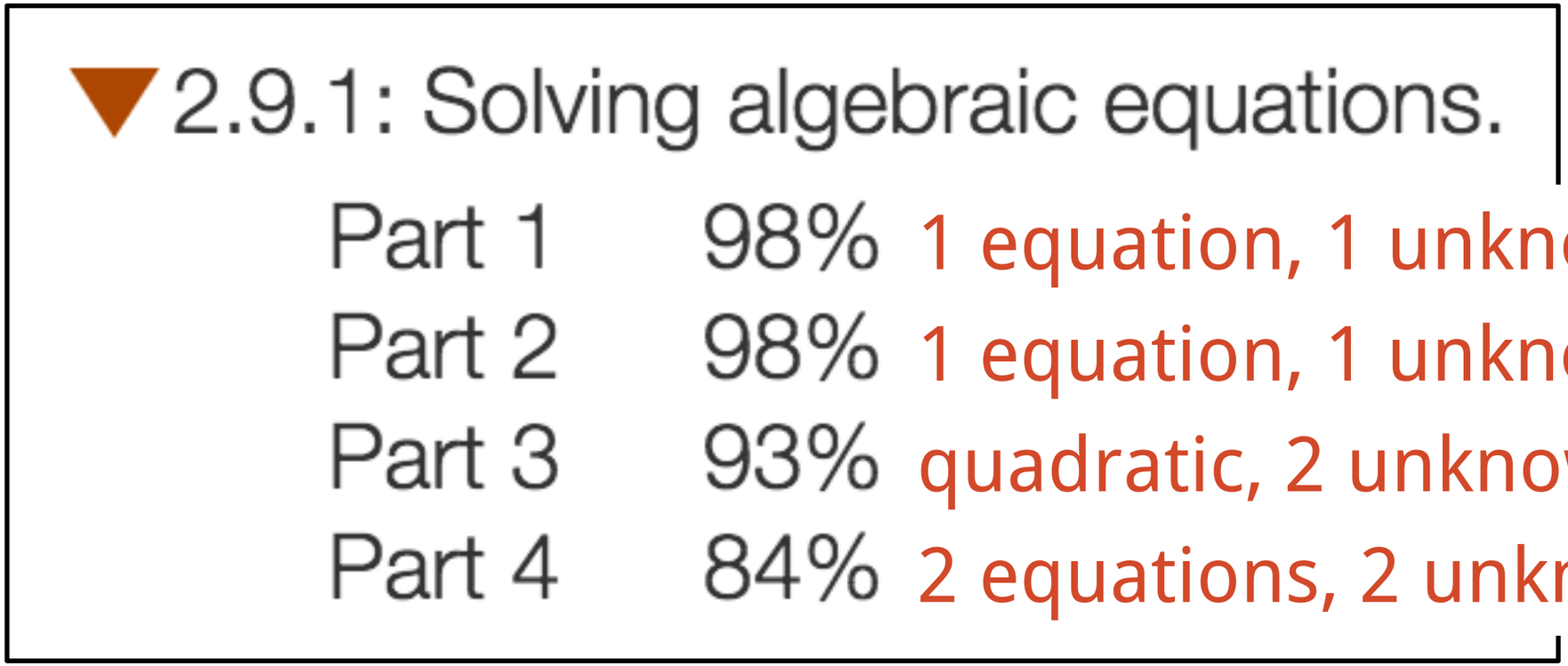
f = 1.0

g = 1.1

i = 1.2

Useful for additional practice & exam prep

Increasing difficulty



Data verifies the progression through levels

Hyp. #2: Students read textbooks

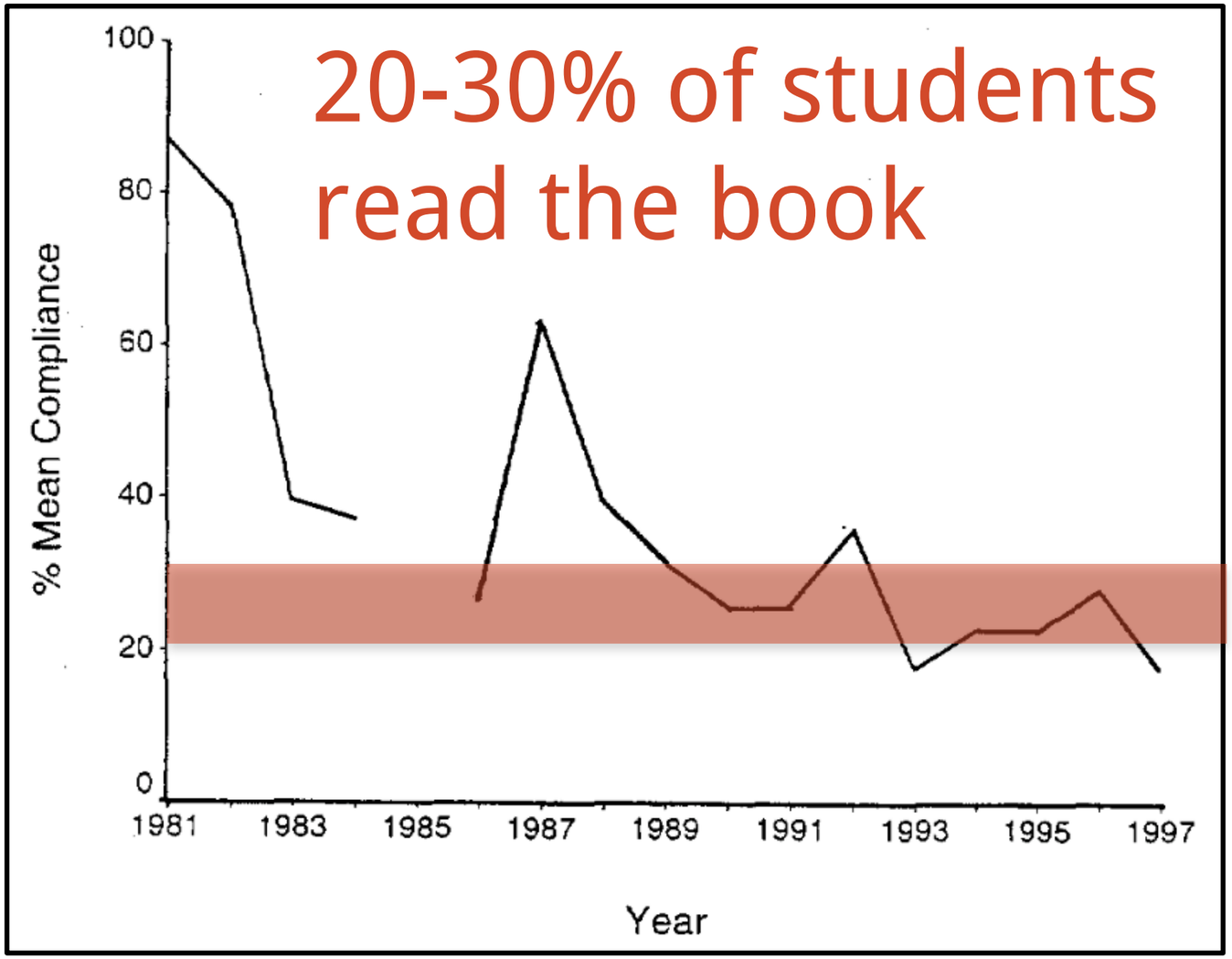
What fraction of your students read the textbook?

How much textbook reading occurs?

> 900 students

Over 16 years

Pop reading quiz once per term



Burchfield & Sappington, *Teaching of Psychology*, 2000. + see proceedings

77,000+ data points in 2016

100 students, 770+ clicks

High reading rate (87% average)

A+B students read significantly more than C+D+F students (92 vs 83% average, $p<0.001$)

Female students read significantly more than male students (94 vs 79% average, $p=0.008$)

Students can read the book…

Comparing 2016 and 2017 courses

2016

Reading 1-5 sections due before most class

Written homework due weekly

Online multiple choice quizzes due monthly

2017

Monday: Reading ~4-5 sections

Wednesday: Challenge activities

Friday: Written homework (zyExercises)

Providing an incentive

Offering 2 to 10% of final course grade led to high reading rates

Edgcomb and Vahid. FIE. 2015. > 1100 students

5% for reading

5% for challenge activities

of final course grade in 2017

84,000+ data points in 2017

88 students, 960+ clicks

High reading rate (93% average)

A+B students read significantly more than C+D+F students (96 vs 87% average, p=0.008)

Female students read significantly more than male students (96 vs 91% average, p=0.04)

Plus more data from challenge activities…

Reading data similar (2017 vs 2016)

High reading rate (93% vs 87% average)

A+B students read significantly more than C+D+F students (p= 0.008 vs <0.001)

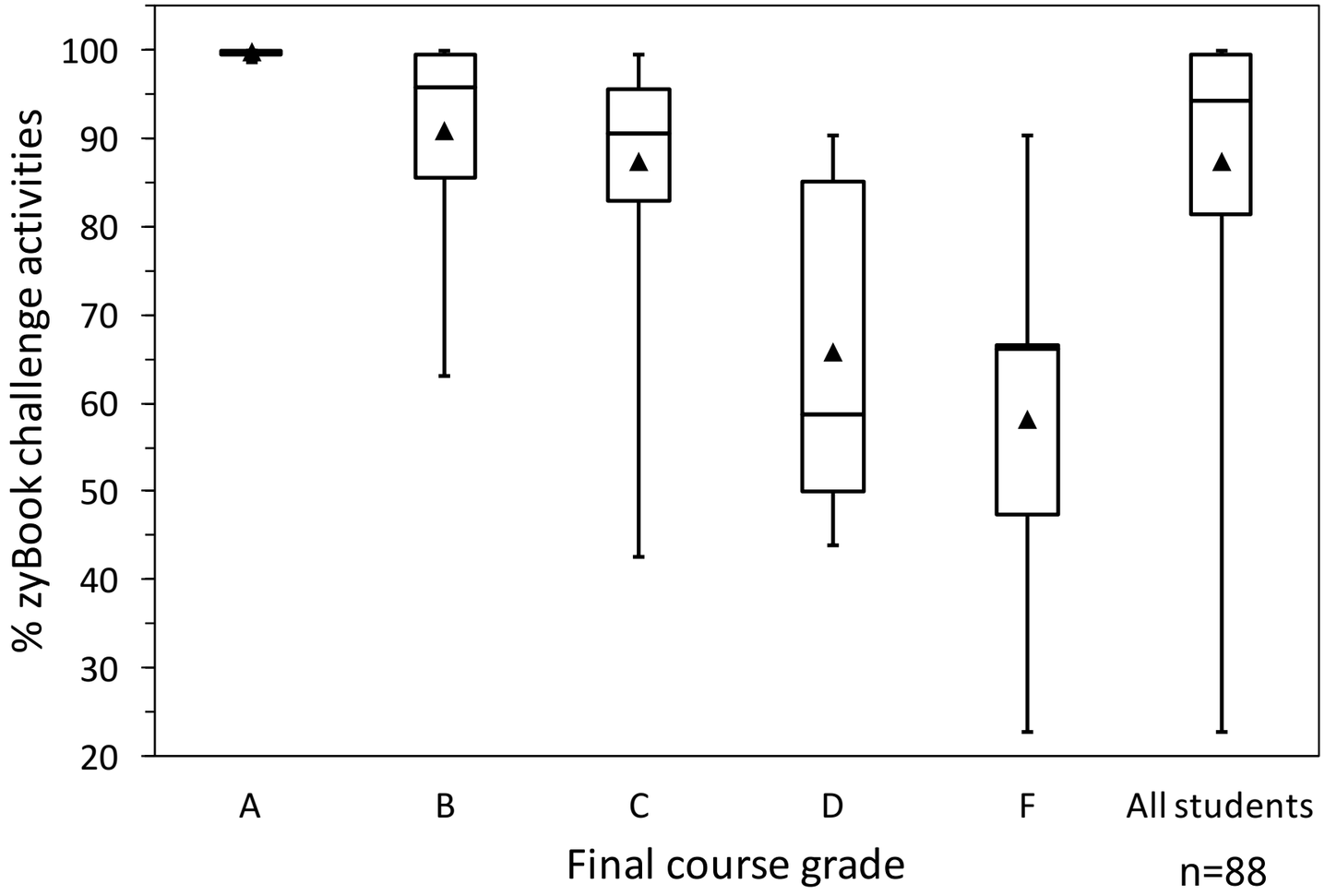
Female students read significantly more than male students (p=0.04 vs 0.008)

Reading consistently high over two years

Reading vs challenge activities

Reading	Challenge activities
Completion score	Correct answer(s)
Clicks through each question, matching, or step in an animation	No limit of attempts
	Number (tolerance)
	Multiple choice
	Chart reading

87% ave. challenge activities (2017)



173 questions plotted – grades out of 160

Hyp. #3: Textbook and repetition

95% of students reported watching an animation more than once (2016 survey)

Challenges activity questions have tens, hundreds, or more variations.

Do students do additional practice?

Animation reruns are common

Chapter 4 through 7

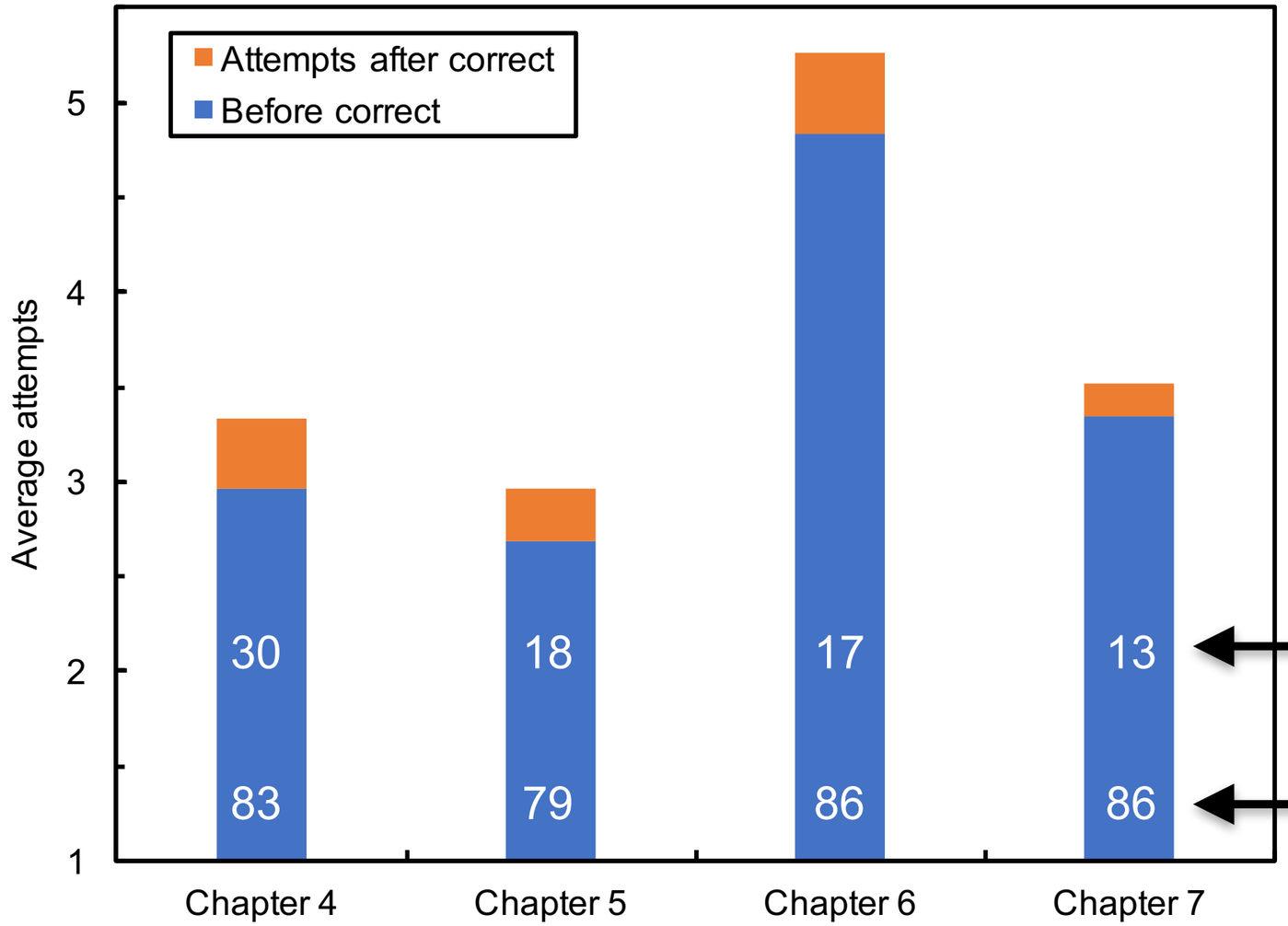
3555 complete views over 36 animations

1.1 views per animations (+9 students)

Re-watching rates varied from 5 to 17% of students

2016 survey results believable

Practicing after getting correct



Orange =
Extra practice,
not for a grade

>2000 ”repetition” attempts (26/question)

New!!! Spreadsheets in zyBook

Start ☐ 2x speed

	f_x					
	A	B	C	D	E	F
1						
2	A1,B3,A5					
3				E5,D2,F1:F3		
4						
5						

Cell lists use commas to define sets of individual cells and/or groups of cells.

Challenge activities create scenarios for calculations and writing formulas

Animations demonstrate spreadsheet concepts

Independent of software type or version

The formula in cell C3 can be copied to fill cells D7 and D8. Enter the calculated value in cell D8 and the pasted formula into cell D7.

	A	B	C	D	E
1	15	74			
2	30	62			
3	11	43	=A$3-3		
4	48	54			
5	31	60			
6	49	77			
7	22	41		=A1+B1	
8	45	30		102	
9	12	43			
10	33	74			

Three hypotheses

1. Engineers are data driven
2. Students read textbooks
3. Students can use a textbook for repetition

Three hypotheses proven

1. Engineers are data driven

   Over >80,000 data points for 1 class

2. Students read **interactive** textbooks

   93% reading/ 87% challenge activities

3. Students can use a textbook for repetition

   ~10% re-watch any single animation

   > 25 attempts/question after correct

Visit ZyBooks Booth 546 for a demo + paper in CEE 2017

In greater detail

Accepted publication:

M.W. Liberatore. “High textbook reading rates when using an interactive textbook for a Material and Energy Balances course”, Chemical Engineering Education, (2017): accepted 12/2016.

WIP: Annotations and discussions of textbooks and papers using a web-based platform

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Textbooks and interactivity

Multi-sensory tools can improve learning

Interactive textbooks showing significant promise e.g., zyBooks

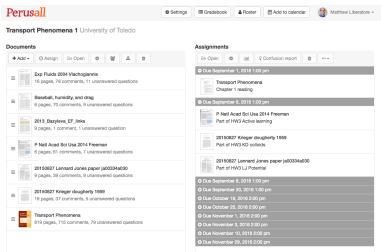
Can widely available, static textbooks be made interactive and engage students?

What is Perusall?

Web-based tool for commenting on static text

Asynchronous responses recorded

Comments scored by machine learning algorithm (hourly)

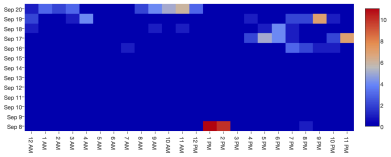


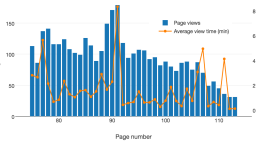
When and how much reading?

Chapter 3 of textbook

Most likely day before and due day

Evening/night more common





1 to 3 minutes per page

Views taper off near the end of ~40 page chapter

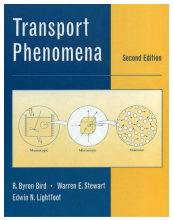
Textbook and journal papers

Graduate course in fluid mechanics

10 graduate students (20% female)

Perusall = 10% of final grade

Textbook: Transport Phenomena by Bird, Stewart, and Lightfoot



5 journal papers

Machine graded scoring

2 points = Relevant
1 point = Minimally relevant
0 point = Irrelevant

Instructor agreed with scoring >99% of time

Total comments written = 1000
Required total comments = 660

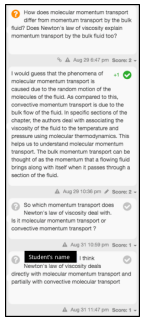
Assignment type	Quantity	Length (pages)	Required comments
Textbook chapters	7	25-40	7
Journal papers	5	6-16	3 to 5

Chapter 3 of textbook

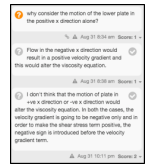
Activity	
12 annotations	7 annotations
7 annotations	7 annotations
9 annotations	11 annotations
15 annotations	9 annotations
21 annotations	11 annotations

70% of students wrote extra annotations to earn full grade

Student to student discussion



Comment types:
Q: Ask your classmates a question
C: If you are confused, try to state your understanding
H: If you can help a classmate, response to C and Q comments
R: Rephrase in a way that you think will be useful to your classmates

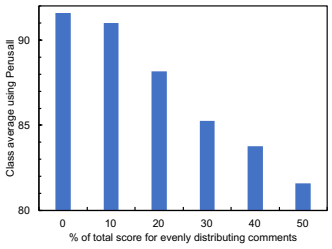


Surveys shows Perusall liked

Statement from end of semester survey	% of students responding strongly agree or agree
I learned new material by responding to other students comments in Perusall.	90
I learned new material by composing questions in Perusall.	90
I found Perusall a useful tool for the course.	80

Students will persist with transparent scoring to earn higher grades and generally like Perusall

Spacing comments across reading



Grades can account for comment distribution across reading

10% of total score for comment distributed used for final grades

Conclusions

Perusall turns static textbook into discussion

Machine grading works well

Students will persist to earn higher scores

Acknowledgments: University of Toledo Faculty Professional Development Fund, Brian Lukoff (Perusall)