

Reading and Repetition Using an Interactive Textbook for Material and Energy Balances

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Acknowledgments: Kayla Chapman, Nneka Azuka, Ian Mashburn, Logan Sherman, zyBooks team, countless TAs



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

Remember your ABCs



Active learning

Big data

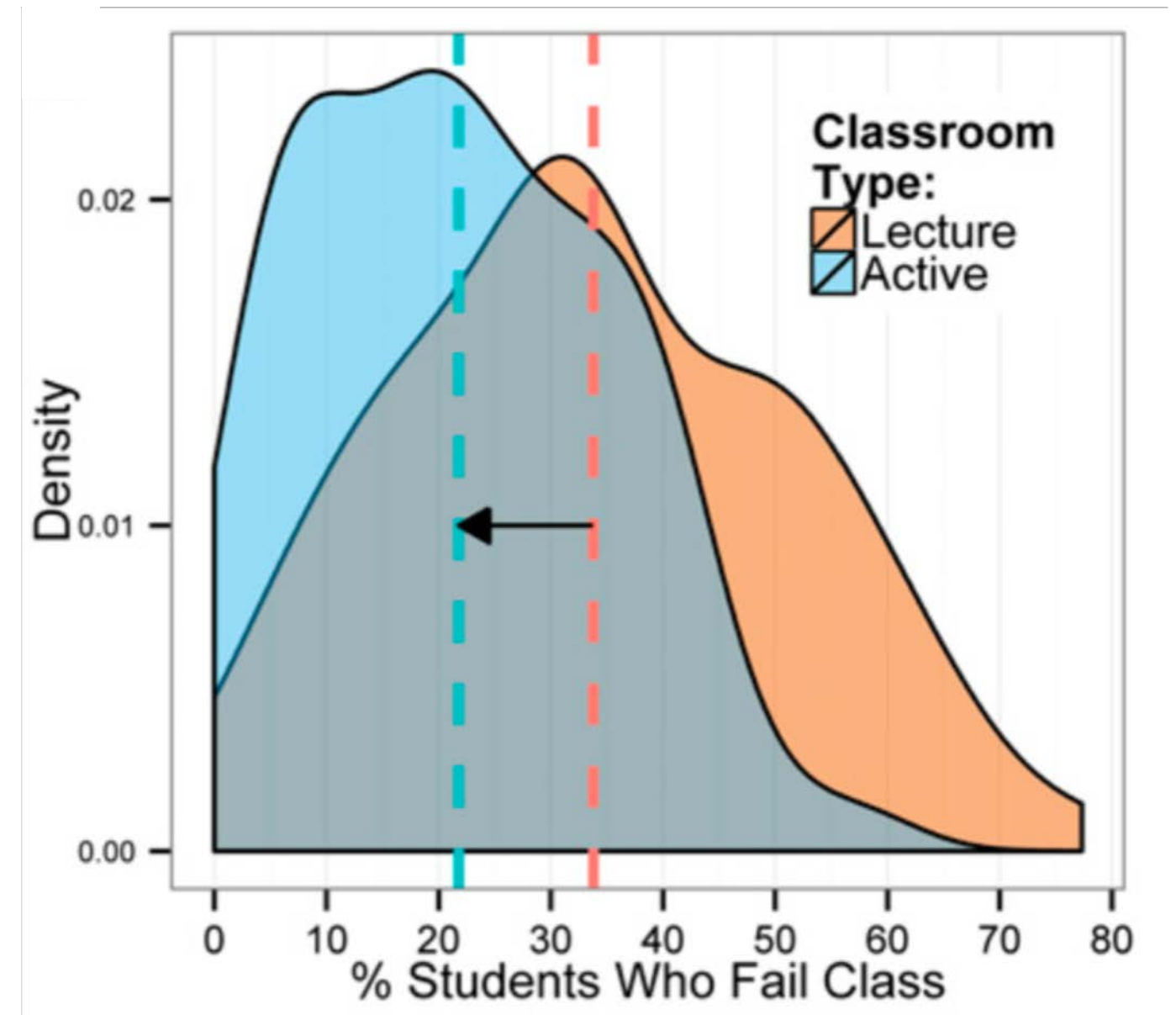
Conclusive, consistent findings

$$A + B = C$$



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

Single studies and meta-analyses show improved learning



Textbooks are a 20th century technology



Today



20th century



1440 AD



3000 BC





What are zyBooks?

Over 450,000 students and 600 institutions

Started by Computer Science faculty in 2012

Fully interactive books

Comprehensive feedback to student and
instructor

Less text, more action™

Looking into the MEB zyBook

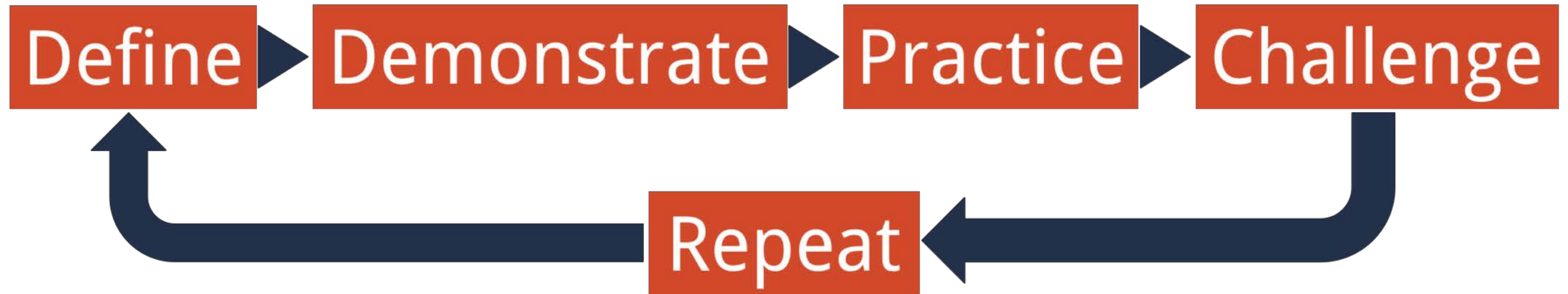


Material and Energy Balances
zyBooks

Manageable chunks for...



Students



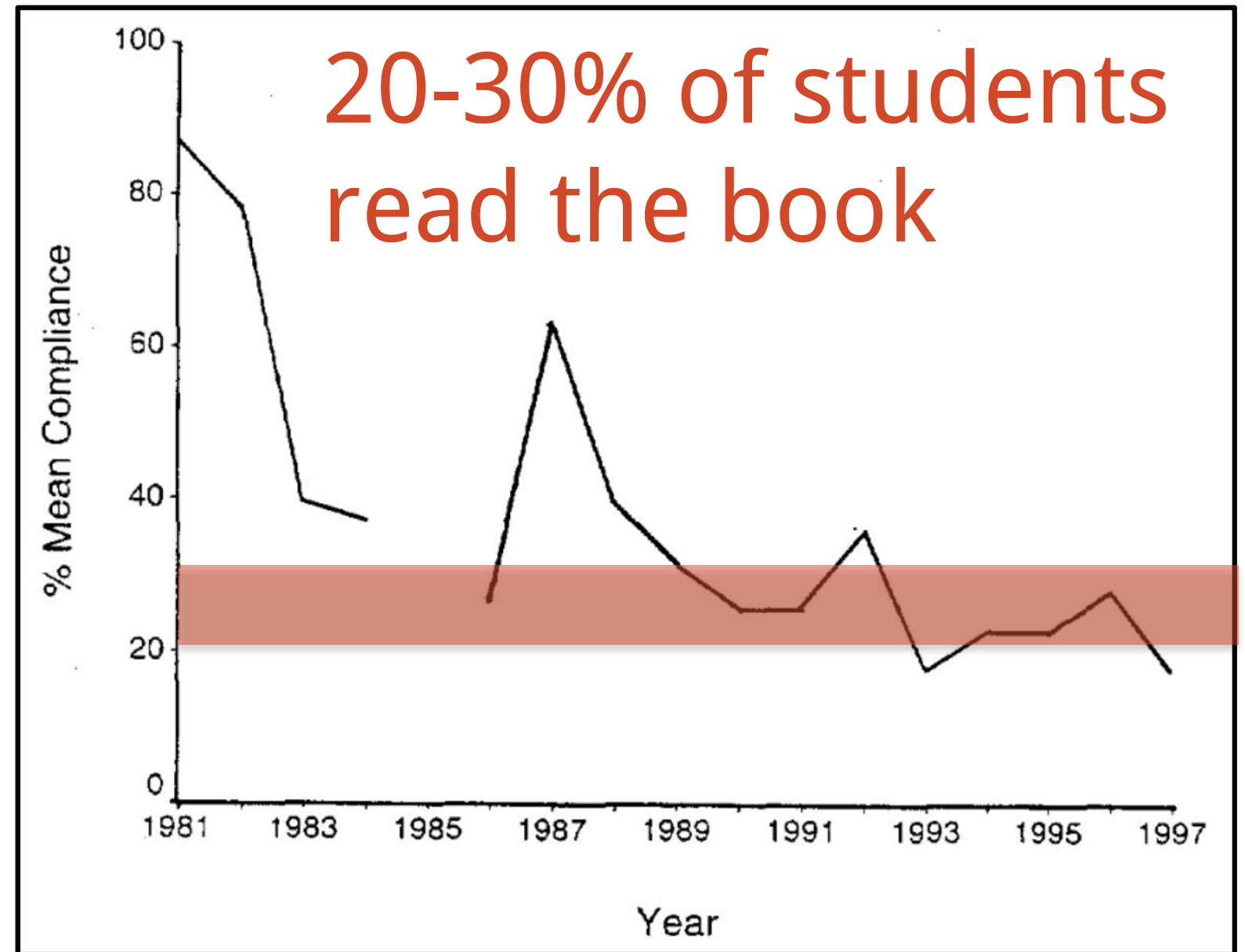
How much textbook reading occurs?



> 900 students

Over 16 years

Pop reading quiz
once per term



Interactive textbook data types



Reading
participation

Animation
views

Challenge
activity
success

Challenge
activity
attempts

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, 2018

Manageable chunks for instructors



☒ 6. Energy Balances	38%	90%	^
☒ 6.1 Forms of energy	60%	91%	▼
☒ 6.2 First law of thermodynamics and the energy balance	60%	91%	▼
☒ 6.3 Enthalpy and tabulated enthalpies	50%	91%	▼
☒ 6.4 Enthalpy and enthalpy paths	32%	91%	▼
☒ 6.5 Heat capacity	27%	91%	▼
☒ 6.6 Humidity	27%	90%	▼

1 day before Challenge due

Manageable chunks for instructors



☒ 6. Energy Balances

85% 90% ^

☒ 6.1 Forms of energy

93% 91% v

☒ 6.2 First law of thermodynamics and the energy balance

93% 91% v

☒ 6.3 Enthalpy and tabulated enthalpies

91% 91% v

☒ 6.4 Enthalpy and enthalpy paths

84% 91% v

☒ 6.5 Heat capacity

78% 91% v

☒ 6.6 Humidity

83% 90% v

When challenge activities due

Three repeatable findings over 3 years



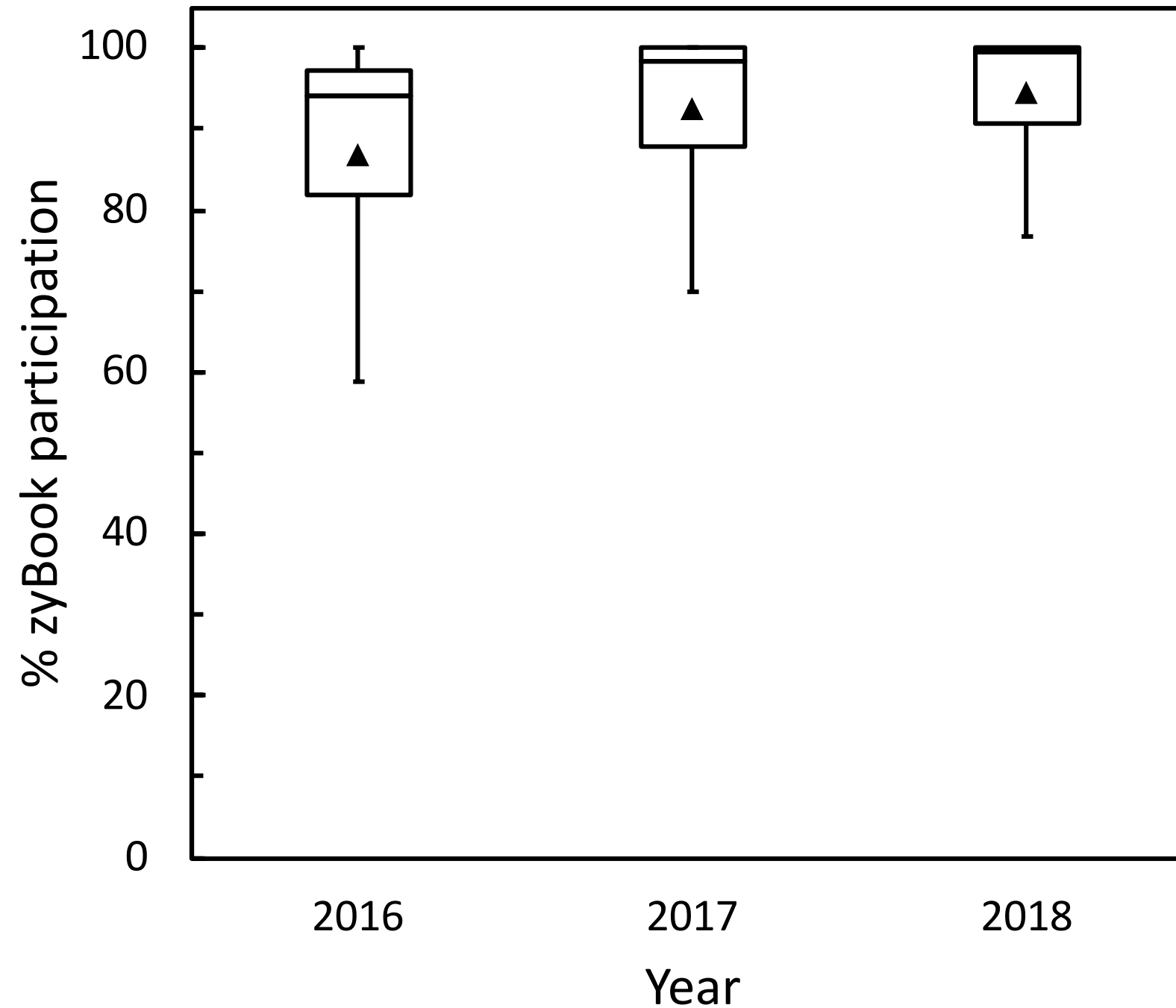
High reading rate

A+B students read significantly more than C+D+F students

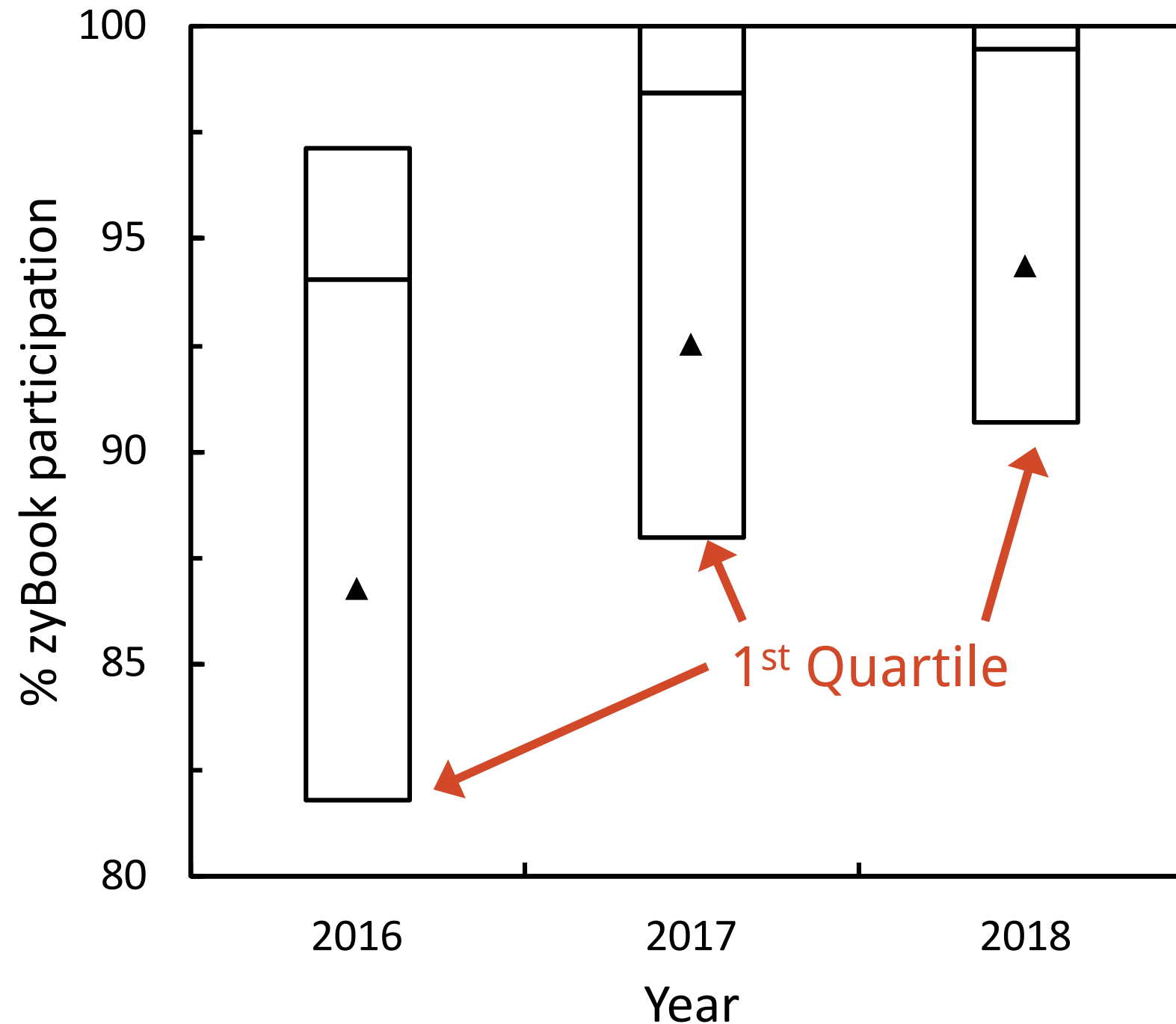
Female students read significantly more than male students

290,000+ reading clicks recorded, 280+ students

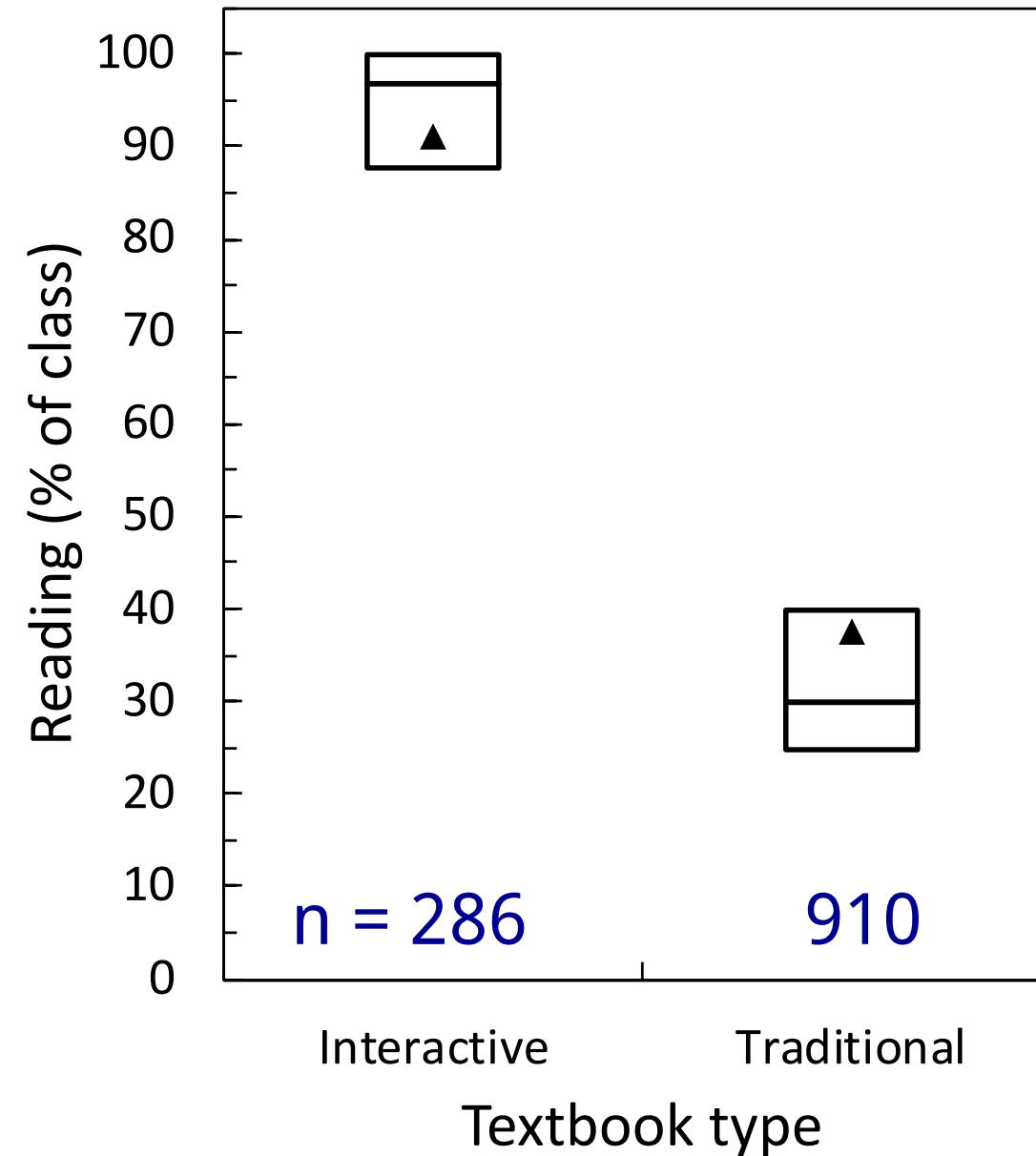
High reading participation...improving



High reading participation...improving



Reading rates: zyBook vs. textbook



Traditional: Burchfield & Sappington, *Teaching of Psychology*, 2000.

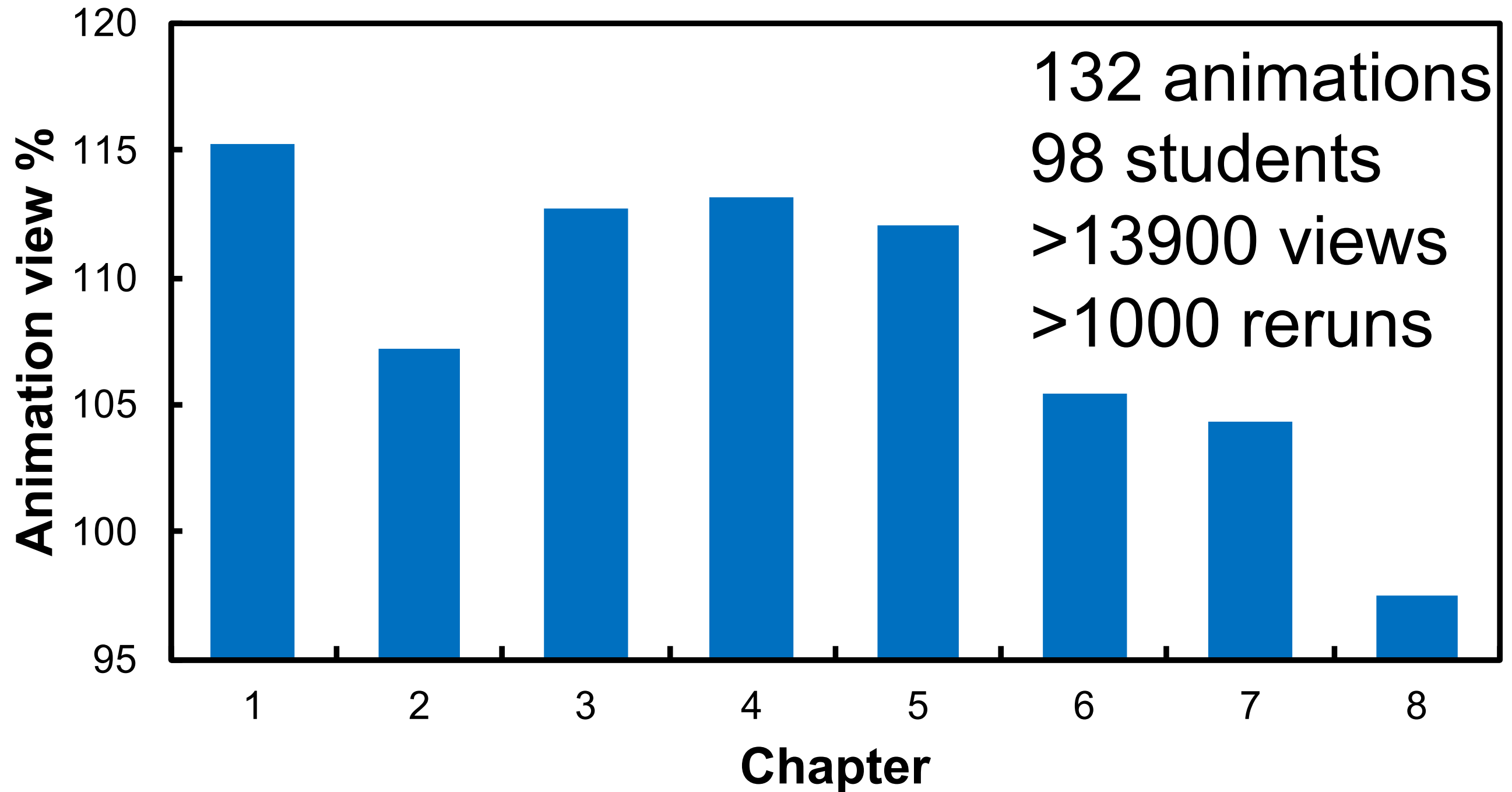
Opportunities for repetition

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

Challenges activity questions have tens, hundreds, or thousands of variations

Do students do additional practice?

Animation 'reruns' are common - 2018



Reading vs challenge activities



Reading

Participation score

Clicks through each question, matching, or step in an animation

Challenge activities

Correct answer(s)

No limit of attempts

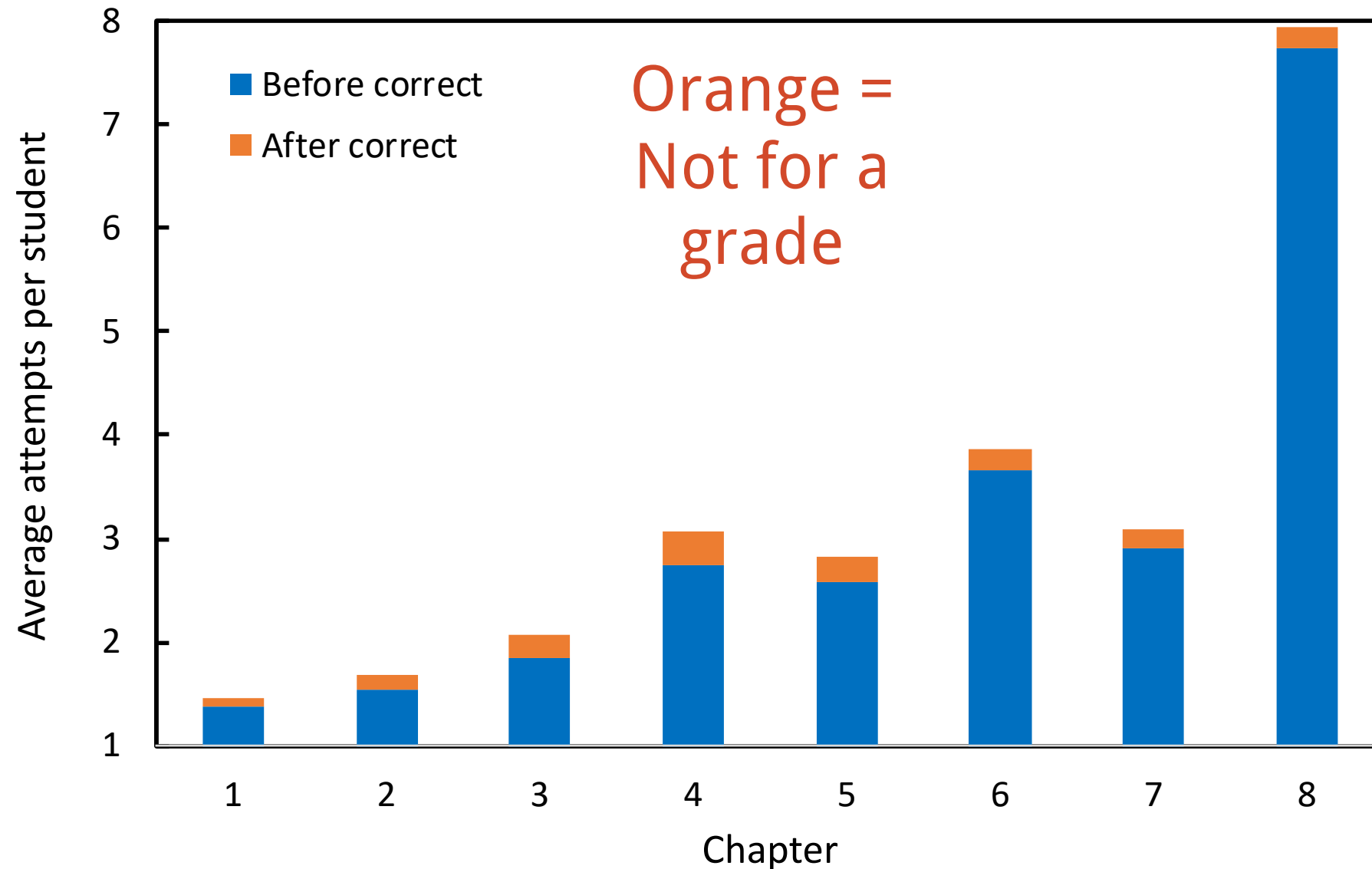
Number with tolerance

Multiple choice

Chart reading

Most data are before due date

Many practice attempts after correct

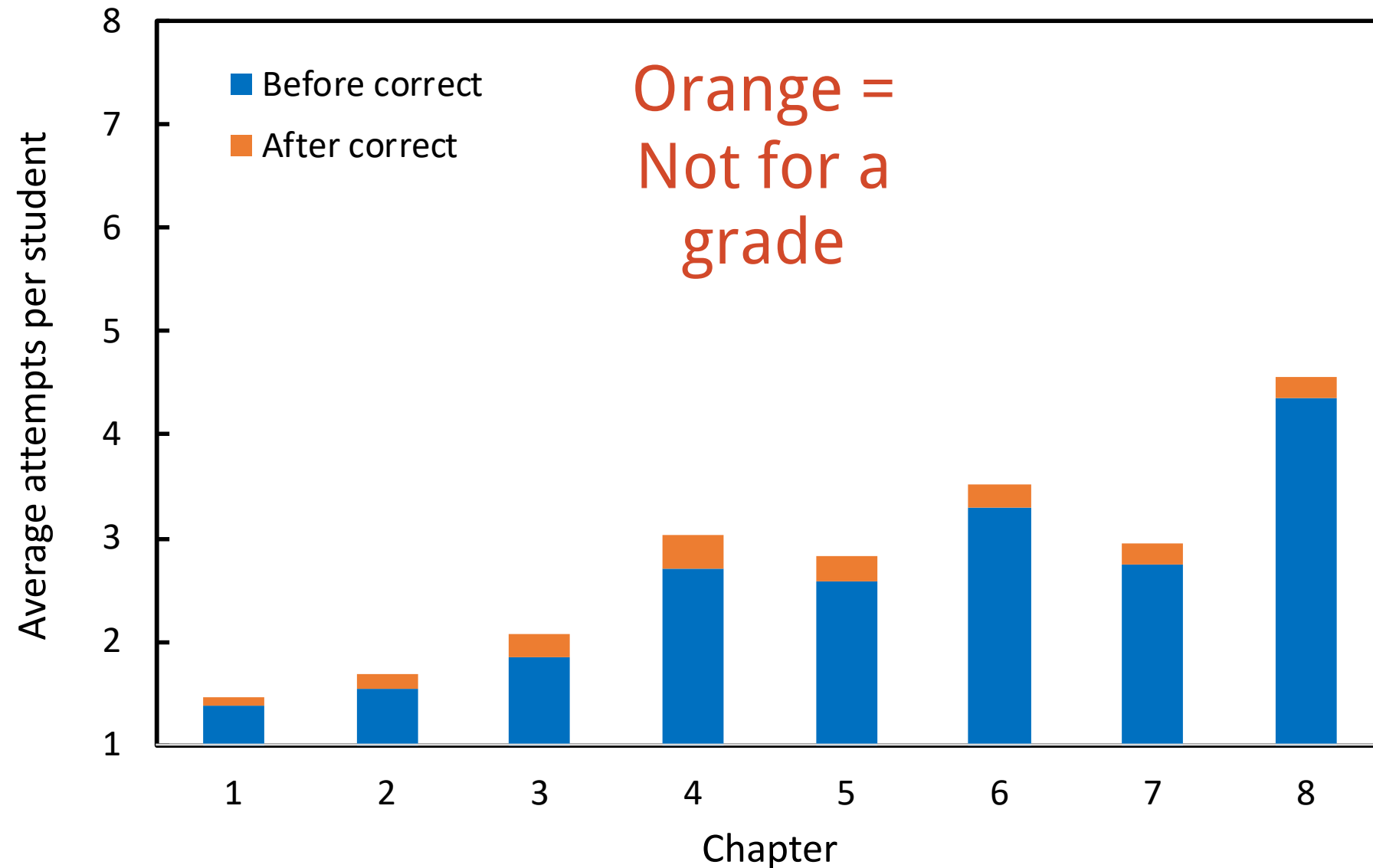


300 questions
98 students

>70,000 total
attempts

>4200 "repetition" attempts (14/question)

Many practice attempts after correct



300 questions
98 students

>70,000 total
attempts

>4200 "repetition" attempts (14/question)

Spreadsheets – see Poster Tuesday



Animations cleanly demonstrate concepts

Start ☐ 2x speed

Equals Function Argument

B2	f_x	<code>=SUM(A2:A1)</code> ← Stored content of Cell B3				
	A	B	C	D	E	F
1	7					
2	1	8 ← Displayed content of Cell B3				

Calculate the logarithm of the number in column A to the base in column C. Enter the calculated number and formula using a spreadsheet function and cell addresses.

	A	B	C
1			
2			
3			
4	37		2
5			

Formula: Value:

Challenge activities create scenarios for calculations and writing formulas

Only auto-graded, randomized spreadsheet practice

Active learning, Big data, Conclusive



>120,000 reading clicks collected

99% reading / 96% challenge activities

108% watch rate for animations

>4,000 practice attempts after correct

For 2018 cohort only. Papers in CEE 2017, ASEE 2017, ASEE 2018...