

# Beginning with the End in Mind: Evidence-based Course Design Practices to Improve Student Engagement and Learning Outcomes

Please say hello  
in the chat and  
let us know  
what discipline  
you are in!

Justin Shaffer  
October 10, 2024

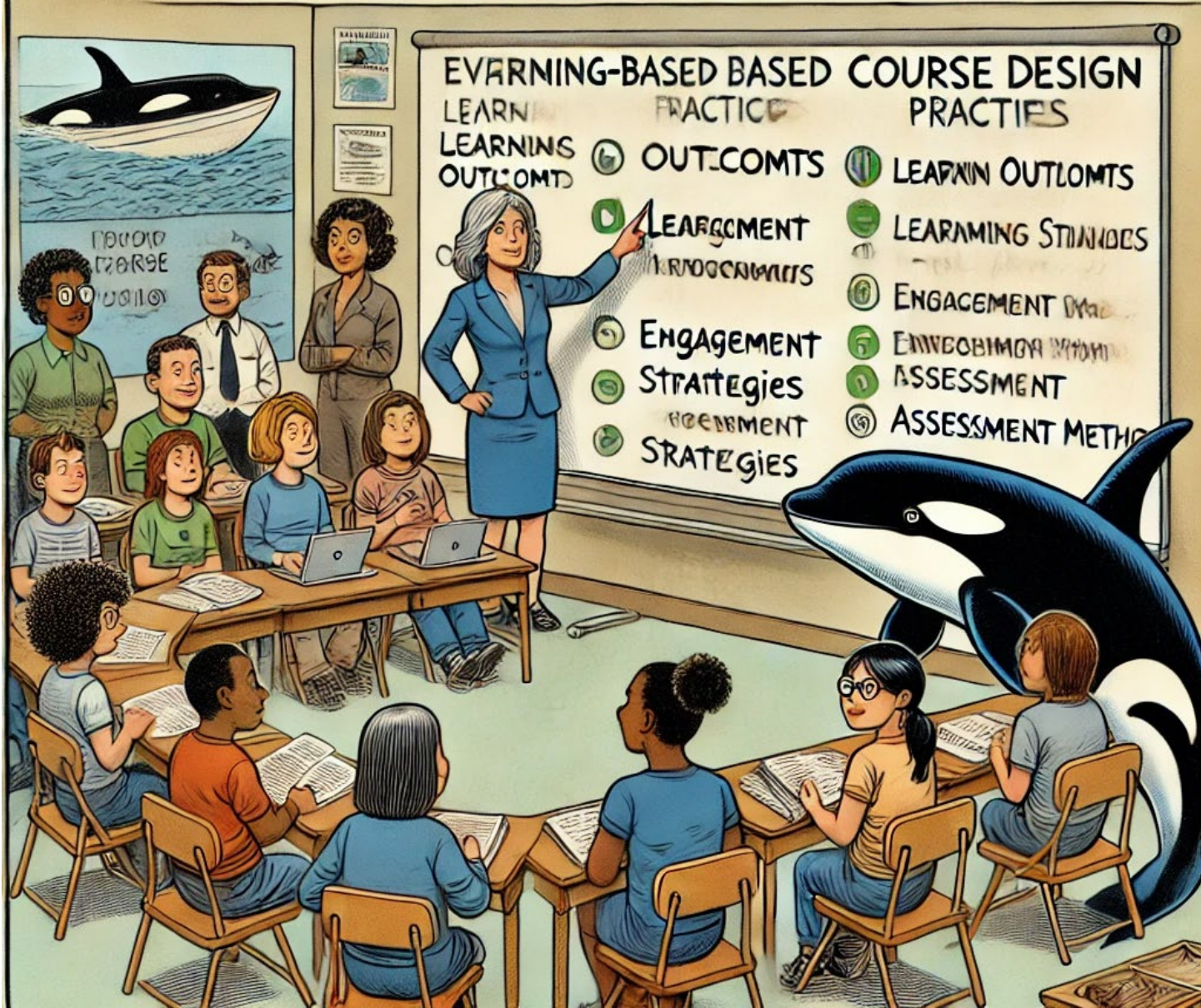


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EARTH • ENERGY • ENVIRONMENT



# BEGINNING WITH THE END IN MIND

## EVIDENCE-BASED COURSE DESIGN PRACTICES



Thanks,  
ChatGPT-

# Learning Objectives

By the end of this webinar, you will be able to...

- Explain what a high structure course is
- Describe the benefits of teaching with high structure
- Be inspired to adopt principles of high structure design into one or more of your own courses!



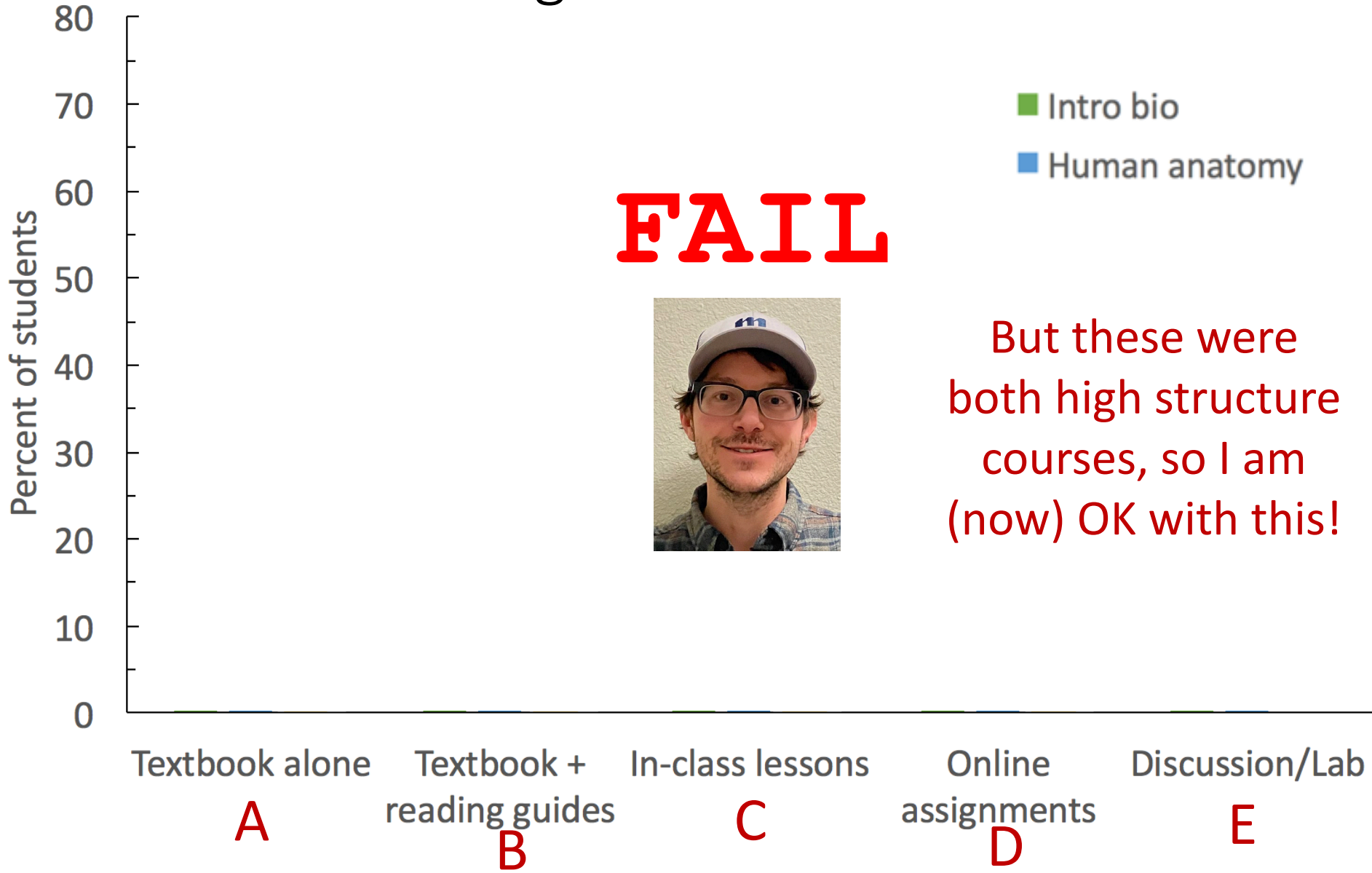
<https://join.iclicker.com/EUXI>

Your chair informs you that you are going to be teaching a new course for the first time this fall (yay!?). What is the first thing you would do with regard to course design?

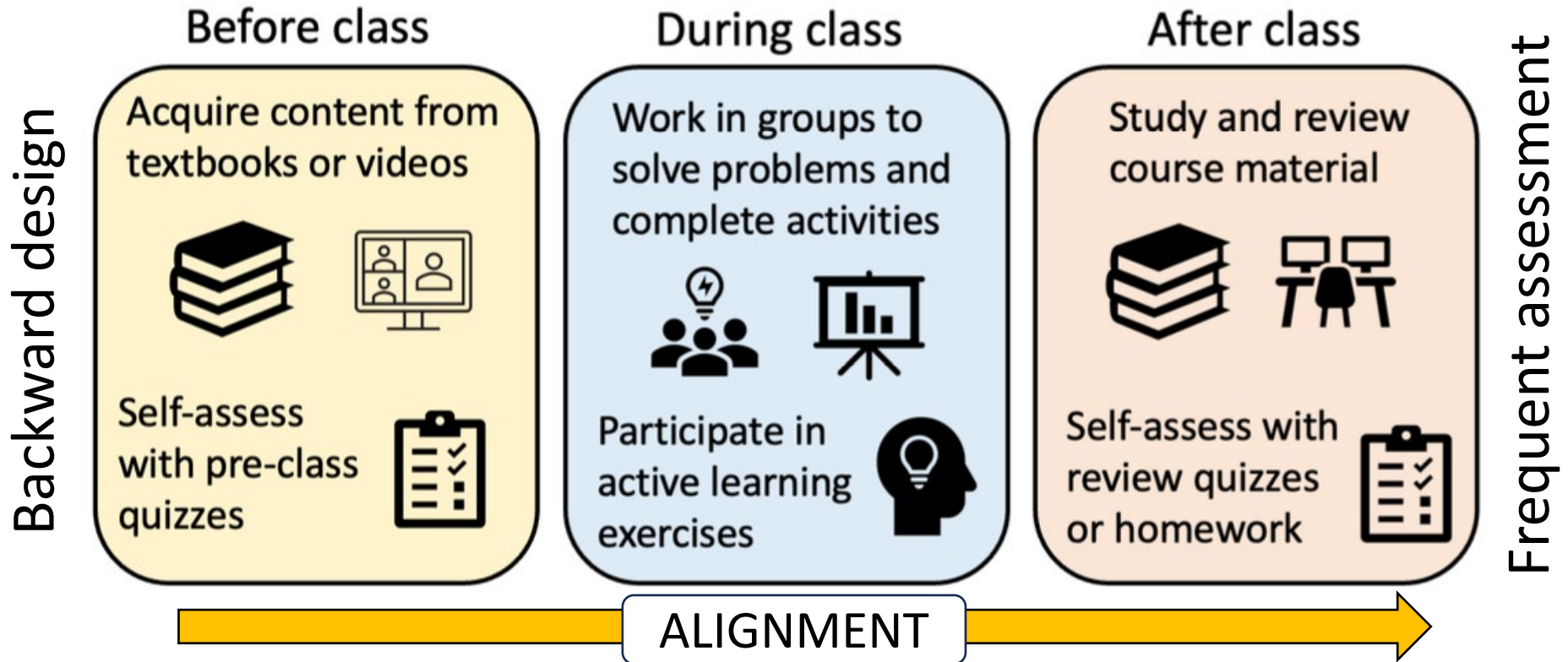
Type your answer into iClicker!  
(140 character limit)



What was the most useful part of the class in terms of learning the material? Select one.



# What are high structure courses?



Which part of high structure do you think would have the most positive impact on your students? Click/tap your screen!

Which part of high structure do you think would be the most challenging to develop/implement? Click/tap your screen!

Backward design

Before class

Acquire content from textbooks or videos



Self-assess with pre-class quizzes



During class

Work in groups to solve problems and complete activities



Participate in active learning exercises



After class

Study and review course material



Self-assess with review quizzes or homework



Frequent assessment

ALIGNMENT

Why teach with high structure?

1. Students perform better<sup>[1,2]</sup>



2. Performance gaps reduce<sup>[3,4,5,6]</sup>



3. Students feel more belonging<sup>[7]</sup>



4. You can do more active learning and higher Bloom's activities in class

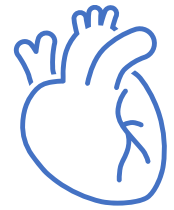


5. You can help students develop self-regulated learning skills



# My high structure courses

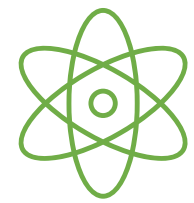
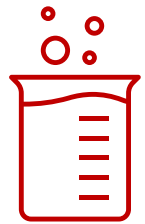
## Biological Sciences



Introductory  
biology

Anatomy  
and  
physiology

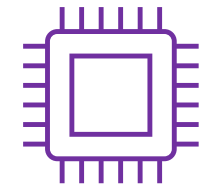
## Chemical Engineering



Introductory  
thermo-  
dynamics

Material  
and energy  
balances

## Biomedical Engineering



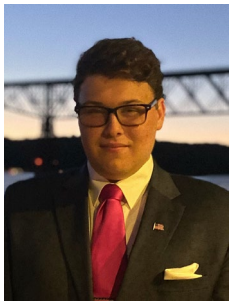
Introduction  
to  
biomedical  
engineering

My research program: developing, implementing, and assessing components of high structure courses





# Impacts of high structure



Coleman Dusavage

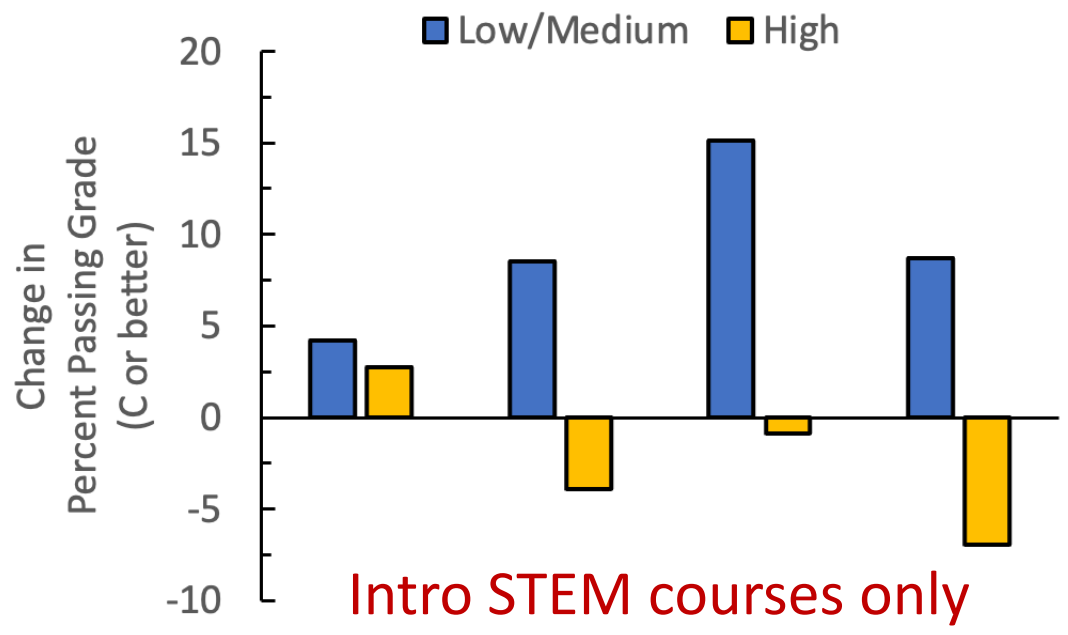
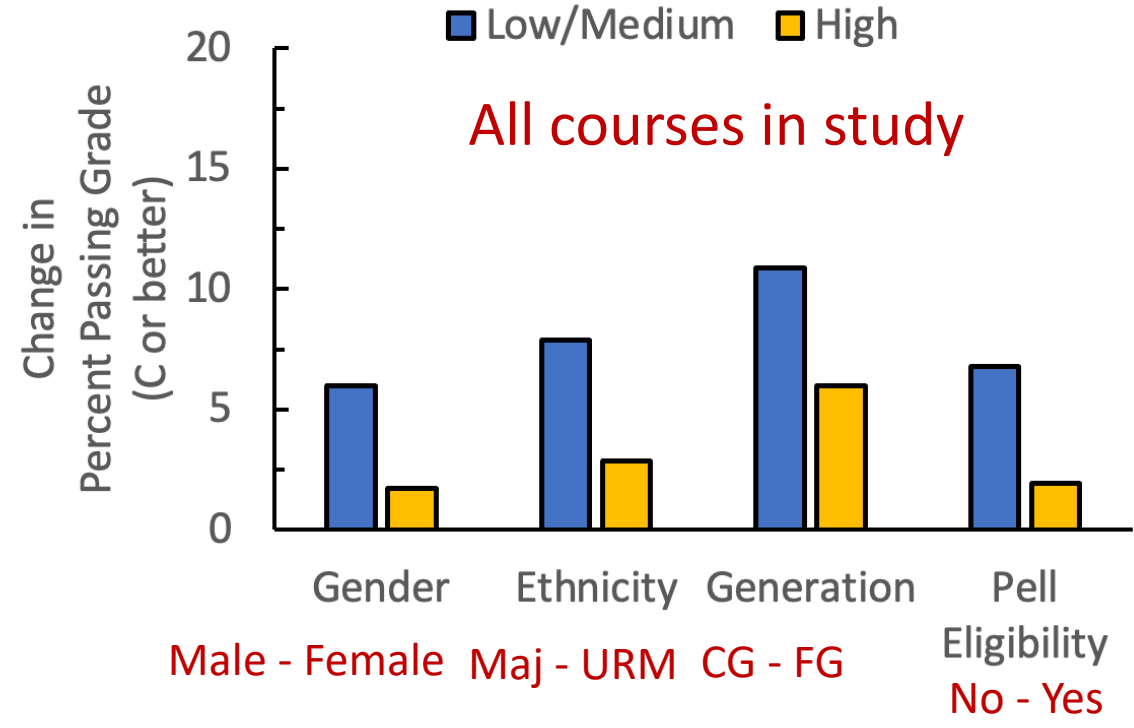


Sidney Wilson

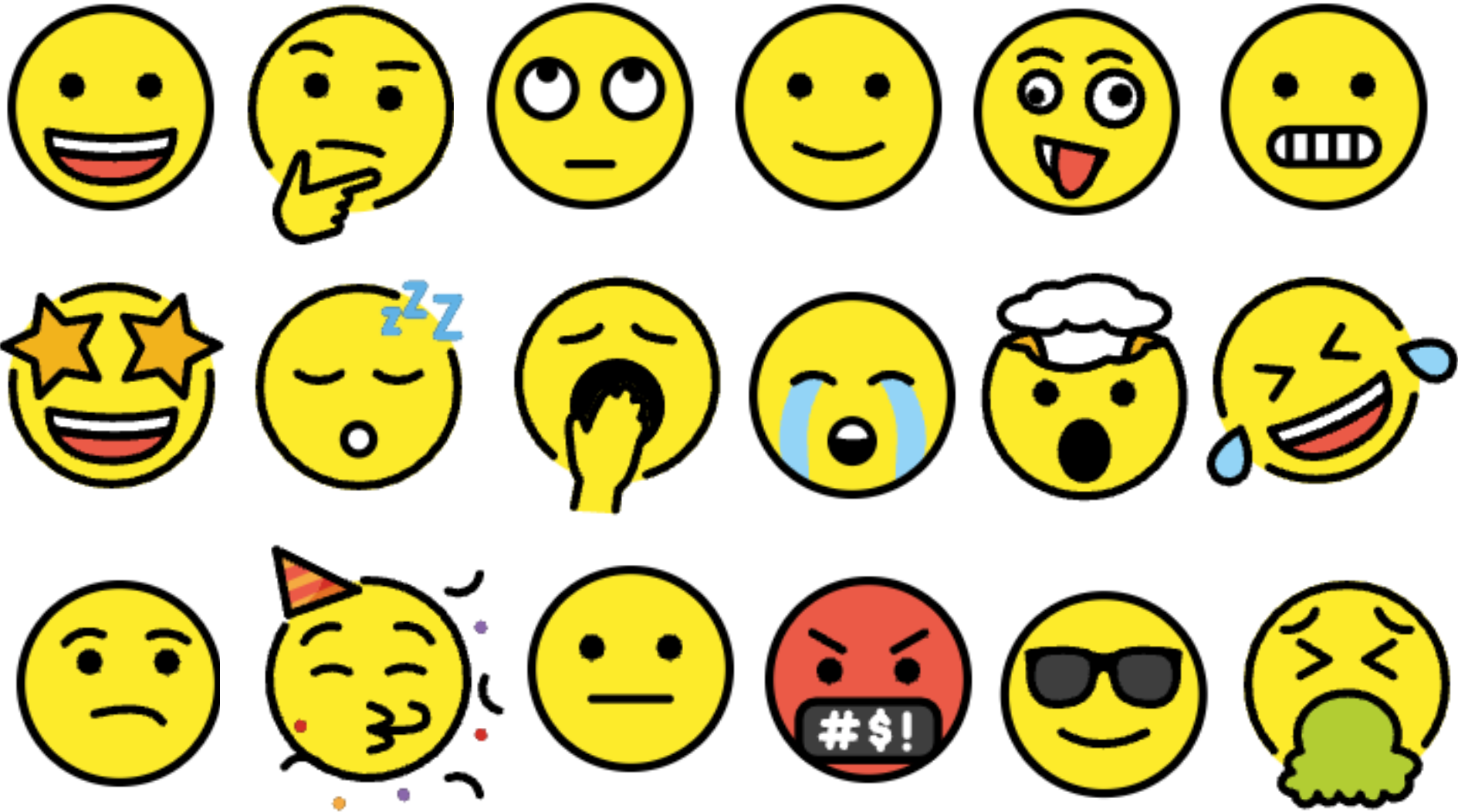


Alex Montoya

- Survey of 69 semesters of 39 unique courses at Mines from Spring 2021 to Spring 2023
  - Biology, chemistry, chemical engineering, civil engineering, computer science, economics, engineering design, electrical engineering, geology, HASS, math, mechanical engineering, physics
- Survey data included usage of pre-class or after-class assignments and estimates of time spent on active learning in class
- Calculated passing rates (C or better) and Z scores to compare between classes



How are you feeling about using high structure at this point?



High structure can be used for *any* course, discipline, level, class size, and format...

But you need to *tailor* the approach to match the needs of your students, instructors, and institution

Let's look at some examples of pieces of high structure that you can use in your courses!

# Pre-class: use reading guides!

THE CHRONICLE OF HIGHER EDUCATION

<https://www.chronicle.com/newsletter/teaching/2024-06-06>

Common elements of reading guides include:

- Define terms
- Summarize concepts in your own words
- Complete tables
- Make drawings
- Answer “concept check” questions from book
- References to specific figures and passages

Redraw Figure 13.4 in the space below. This will help you distinguish between sister chromatids and homologous chromosomes and will help you work with the  $n$  notation.

Describe the human life cycle, using the words mitosis, meiosis, sperm, egg, zygote, and fertilization. See Figure 13.5 for help.

*Skip section on the variety of sexual life cycles and go to page 257 (concept 13.3).*

Answer concept check 13.2 question 1 on page 257 in the space below.

Briefly explain how meiosis I and meiosis II result in four haploid daughter cells (rather than two diploid cells which are obtained through mitosis). See Figure 13.7 for help.

What separates in meiosis I? What separates in meiosis II? Which is similar to mitosis?

Use Figure 13.8 to complete the following table that summarizes the stages of meiosis I and meiosis II.

Stage	Brief summary of what happens in this stage	What is happening to chromosomes in this stage?	Draw what a cell might look like that is going through this stage
<u>Prophase I</u>			
<u>Metaphase I</u>			

This!

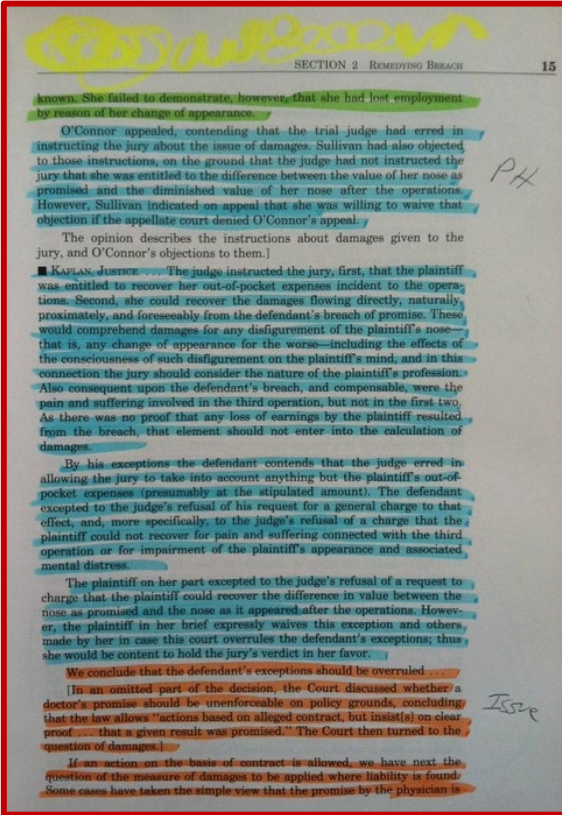


Not this!



[www.tinyurl.com/REmaterials](http://www.tinyurl.com/REmaterials)

Need to follow up with a pre-class quiz or assignment





# In-class: use clickers (classroom response systems)!



- iClickers improve student engagement and participation
- iClickers improve attendance, retention, and *sometimes* grades
- iClickers give you a quick peek into what your students know at any given time
- iClickers are a low- or no-stakes way for students to assess their learning in real-time

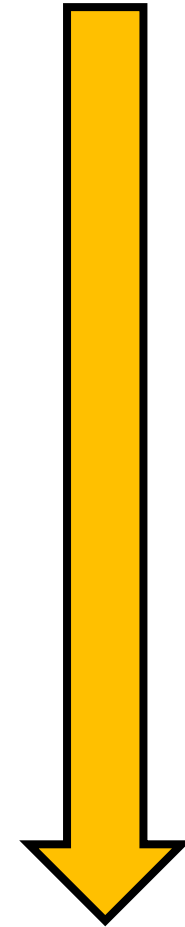


Clickers research bibliography  
<https://cft.vanderbilt.edu/classroom-response-system-clickers-bibliography/>



# After-class: use authentic assessment!

- Integrating news stories
- Add problems from real exams
- Guest speakers
- Reading journal articles
- Case studies
- Podcasts
- Projects
- Field trips
- Real hands-on experiences



*Easier  
to add*

*Harder  
to add*



**Great practical summary of authentic assessment**

<https://citl.indiana.edu/teaching-resources/assessing-student-learning/authentic-assessment/index.html>

# Assessment: use frequent quizzes!

- High stakes exams have been linked to increased student cheating, stress, and anxiety
- Use more frequent, lower-stakes quizzes instead of (or in addition to) less-frequent, higher-stakes exams

**Regarding Class Quizzes: a Meta-analytic Synthesis of Studies on the Relationship Between Frequent Low-Stakes Testing and Class Performance**

Lukas K. Sotola<sup>1</sup>  • Marcus Crede<sup>1</sup>

Educational Psychology Review (2021) 33:407–426  
<https://doi.org/10.1007/s10648-020-09563-9>

Meta-analysis showed significant positive correlations between use of frequent low-stakes quizzes and student learning

**The effect of frequent quizzes on short- and long-term academic performance**

Geist JR, SE Soehren

First published: 01 April 1997 | <https://doi.org/10.1002/j.0022-0337.1997.61.4.tb03123.x> |

Students with frequent, low-stakes in-class quizzes scored higher on midterm and final exams and rated instructors more positively than students with only midterm and final exams

Don't forget those authentic assessments too!

What pieces of high structure are you already doing in your courses? Select all that apply.

A – Pre-class reading / video watching

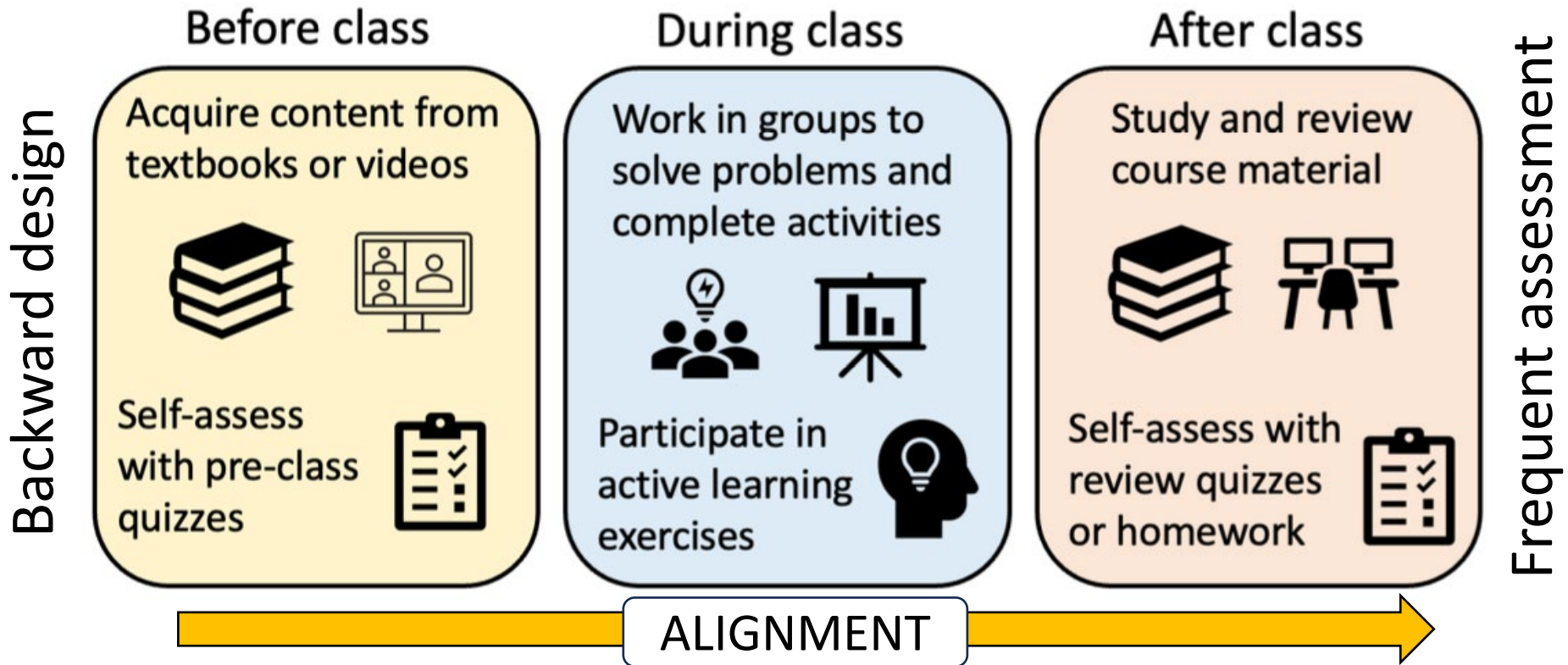
B – Pre-class assessments (graded)

C – In-class active learning

D – After-class *authentic* assignments (graded)

E – Frequent summative assessments (at least every two weeks)

Start slow, build on what you already have, and enjoy the benefits!



What is one word you would use to describe high structure course design?

Type it into iClicker!

# (Almost) closing thoughts...

- What do you like about high structure? What don't you like?
- How do you think this course design model would be received by your students? Colleagues? Administrators?
- Do you think high structure would work in your discipline? Do you think it would work better in some disciplines than others?
- What resources would you need to implement high structure in your own courses?



Let's think about impact...

Former teaching philosophy

I know that I won't ever find a cure for cancer,  
but maybe **I will inspire a student** who will  
someday do just that

Updated teaching philosophy

I know that I won't ever find a cure for cancer,  
but maybe **I will inspire an instructor who will  
inspire a student** who will someday do just that

Working with faculty and future faculty is key  
to spreading evidence-based principles and  
improving student outcomes

# Thank you so much! Happy course designing!



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www.recombinanteducation.com



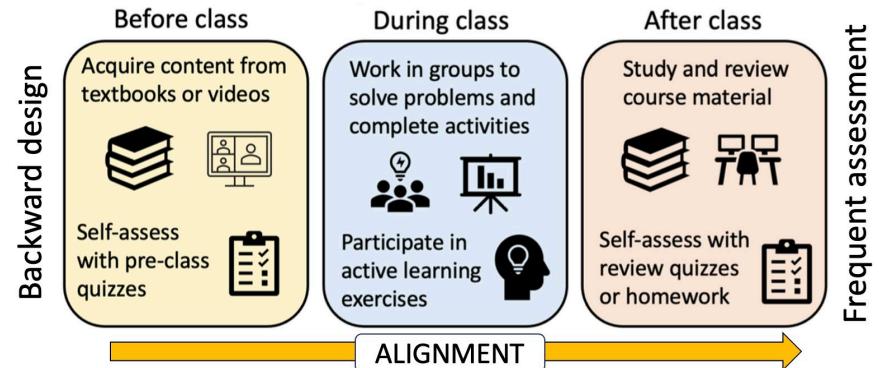
justin-shaffer



Enjoyed this  
webinar? Let  
your colleagues  
know! 😊

## High structure course design book coming soon!

[tinyurl.com/HSCDbook](https://tinyurl.com/HSCDbook)



# References

1. Freeman, S., D. Haak and M. P. Wenderoth (2011). "Increased Course Structure Improves Performance in Introductory Biology." *CBE-Life Sciences Education* 10(2): 175-186.
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3. Haak, D. C., J. HilleRisLambers, E. Pitre and S. Freeman (2011). "Increased Structure and Active Learning Reduce the Achievement Gap in Introductory Biology." *Science* 332(6034): 1213-1216.
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