

# *Assessment and Reflection*

## Flipping the Script: Innovating Large Undergraduate Lectures with Principles from Cognitive Science

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**LRDC**

Learning Research &  
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Discipline-Based

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Science Education Research Center



# Problem

- Large lecture (n > 100) affords direct instruction w/ limited discussion
- Less effective than other learning activities  
(Chi, 2009; Chi & Wiley, 2015)
- Challenge to keep students actively engaged and motivated  
(Leicht et al., 2013; Hake, 1998; Strayer, 2013)





# Solution and Challenge

- Solution: Principles of cognitive science  
(Branford, Brown, & Cocking, 2000; Dunlosky et al., 2013)
  - Self-explanation, analogical comparison, and retrieval-practice
- Challenge
  - How to implement and integrate these principles into instruction for a large lecture course?
    - flipping class content and activity (e.g., Leicht et al., 2012)
  - Opportunity: Relatively little is known about how these principles impact student motivation (interest, goals, beliefs)  
(Belenky & Nokes-Malach, 2012; Zepeda et al., 2015)

# Self-Explanation



## House

Isa: building

Parts: rooms and windows

Materials: wood, brick, stone

Function: human dwelling

Shape: rectilinear, triangular

Size: 100-10,000 sq ft.

- Explanation of worked examples or expository text (Chiu & Chi, 2014; Fonseca & Chi, 2011)
- Why?
  - Generating inferences from prior knowledge (Chi, 2000)
  - Helps to repair mental models (Chi, 2000)
  - Explanation helps identify sub-goals (Catrambone, 1996)
- Laboratory evidence across a number of domains: physics, biology, mathematics, electronics

# Analogy

- Analogies can facilitate learning and problem solving (Gentner, Holyoak, & Kokinov, 2001)
- Why?
  - Facilitates abstraction, acquisition of a problem schema, and a focus on the underlying concept (e.g., Gick & Holyoak, 1983; Nokes-Malach et al., 2013)

What is similar across the problems?

## House

Isa: building  
Parts: rooms and windows  
Materials: wood, brick, stone  
Function: human dwelling  
Shape: rectilinear, triangular  
Size: 100-10,000 sq ft.

**John's house** is a building where he lives that consists of 10 rooms and 20 windows. It is made of wood and brick. It is a large rectangle and is approximately 9,000 sq. feet.

**Sarah's House** is a building where she and her family lives that consists of 5 rooms and 9 windows. It is made of brick and stone. It is a large rectangle and is approximately 3,450 sq. feet.



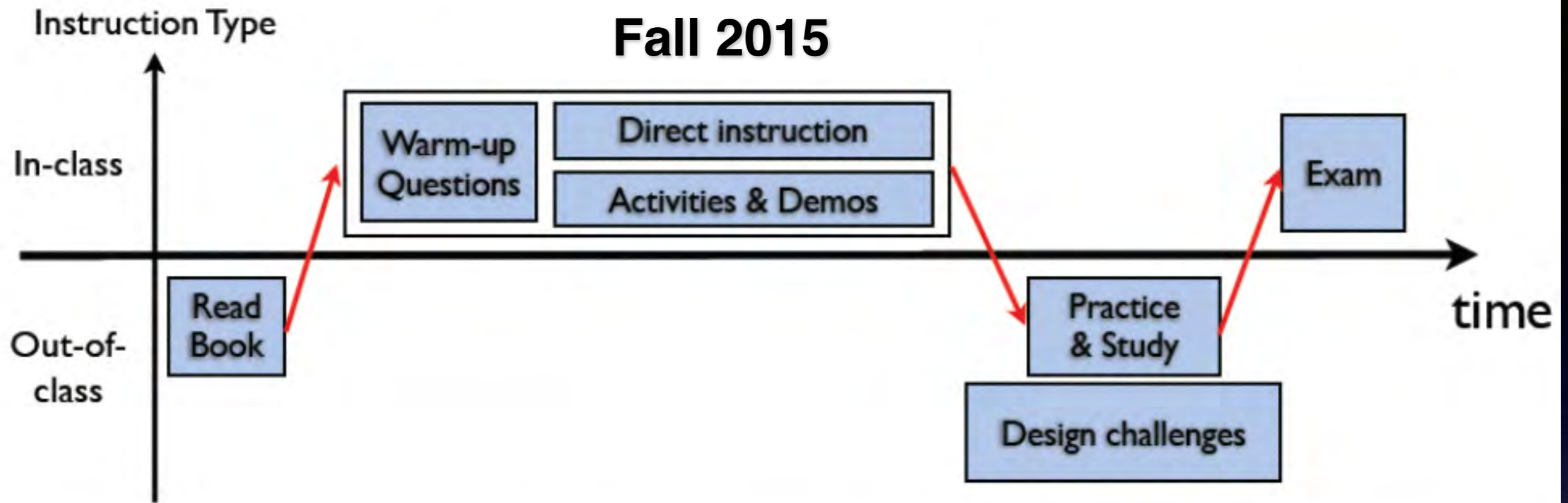
# Retrieval practice

- Testing that is completed as a formative assessment
- Many studies have shown that it improves learning and retention compared to restudy (Karpicke & Roediger, 2006)
- Why?
  - Direct effects: generative versus passive; elaborative retrieval processes (activates related info); organization of retrieval
  - Indirect effects: figure out what one does not know, opportunity for future study

# Class

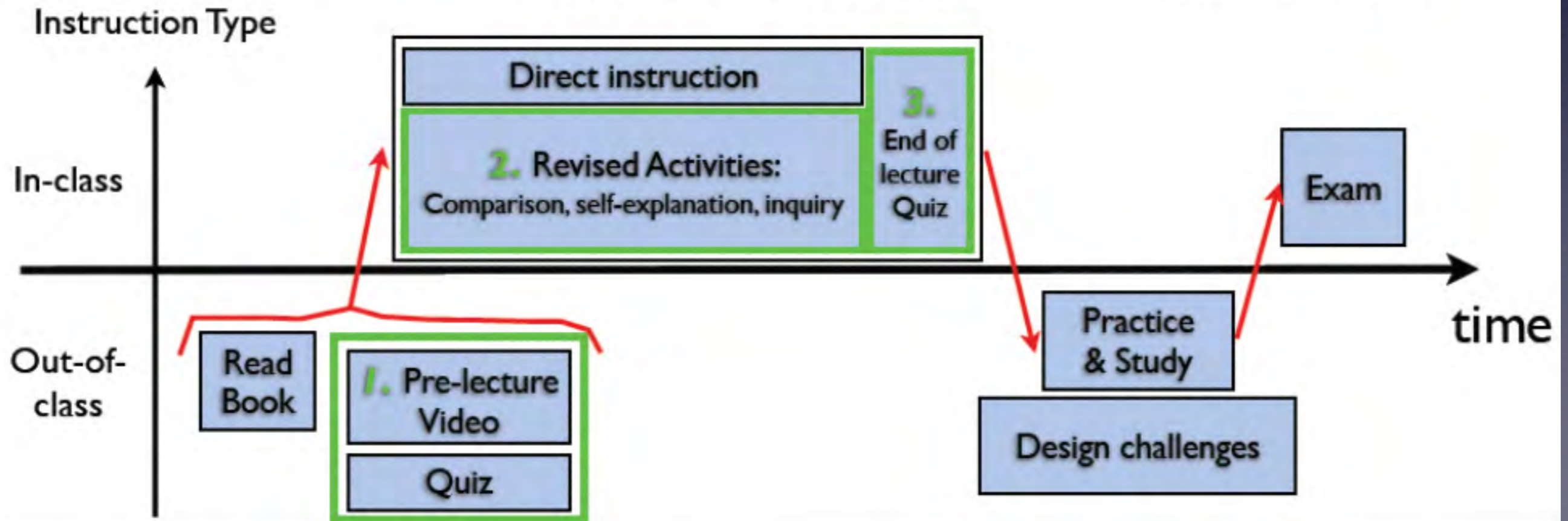
- 422 Cognitive Psychology
  - Science of the mind: perception, attention, memory, language, concepts, problem solving, expertise, creativity, etc.
- One of five psychology core courses
- 200 students
  - About even split between sophomore, junior, and senior
- ~ 65/35 split between Major and Non-majors

# Fall 2015



# Spring 2016 Flipped Instruction

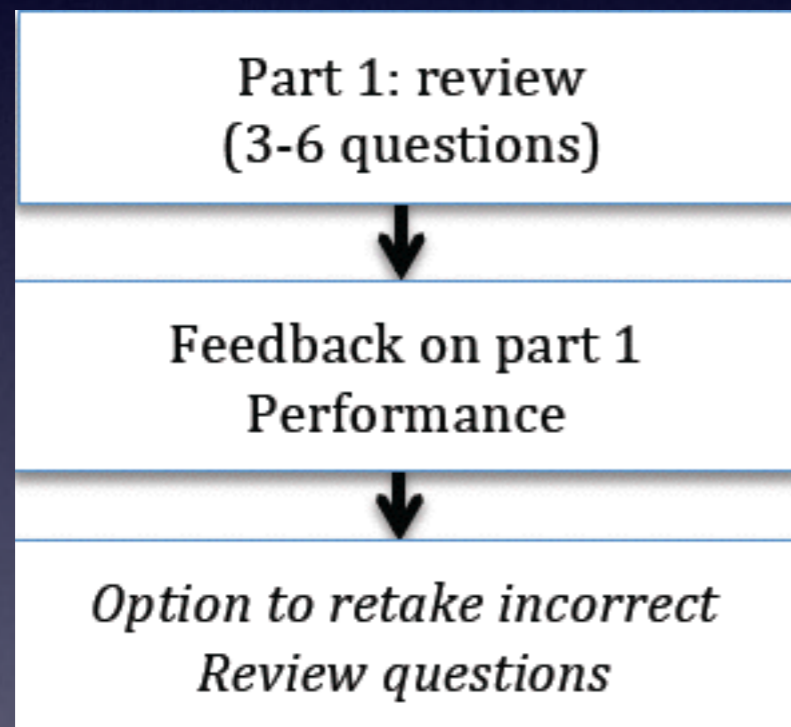
Major Revisions ■





# Pre-lecture quiz and video

- 8 pre-lecture quizzes and videos



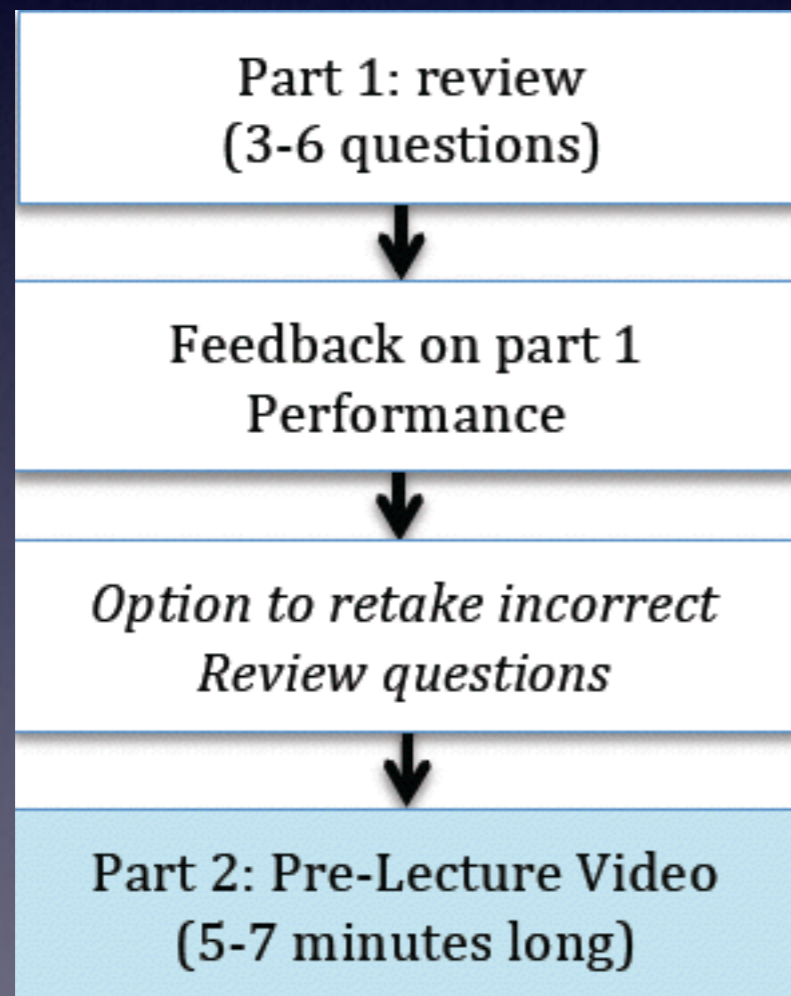
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In visual perception, top-down processing is:

- A. Influenced by prior knowledge and driven by expectations
- B. Influenced by the environment and driven sensory information
- C. Out of one's control
- D. B and C only

# Pre-lecture quiz and video

- 8 pre-lecture quizzes and videos

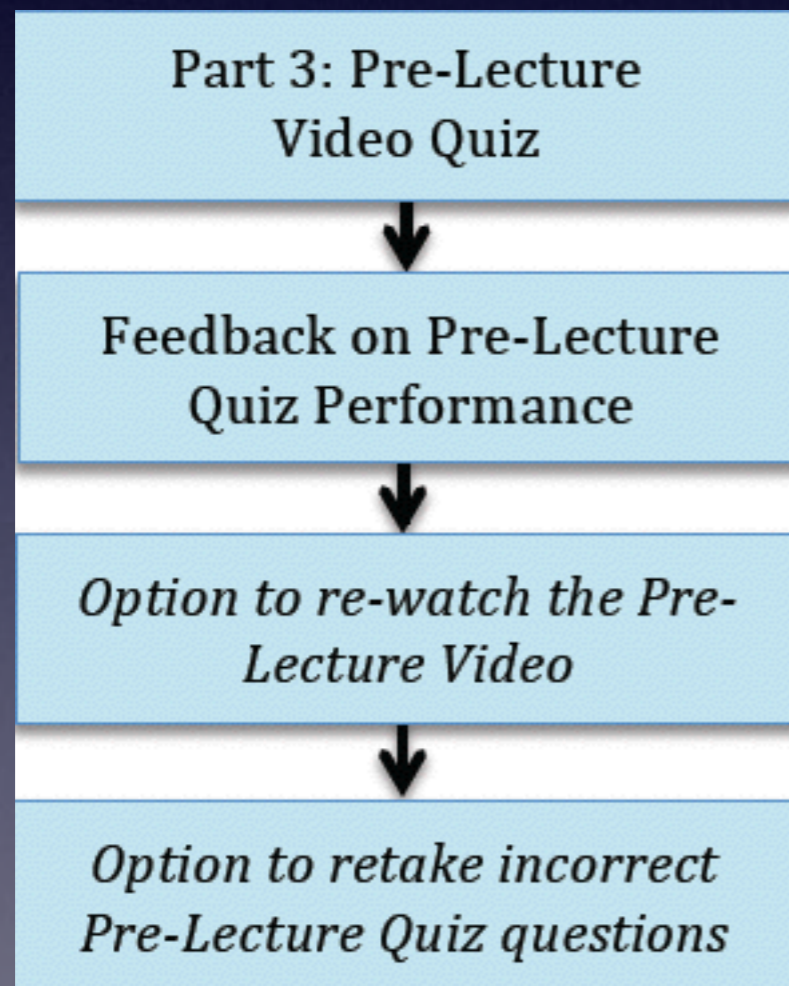



Attention



# Pre-lecture quiz and video

- 8 pre-lecture quizzes and videos



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Please answer the following questions about the video you just watched.

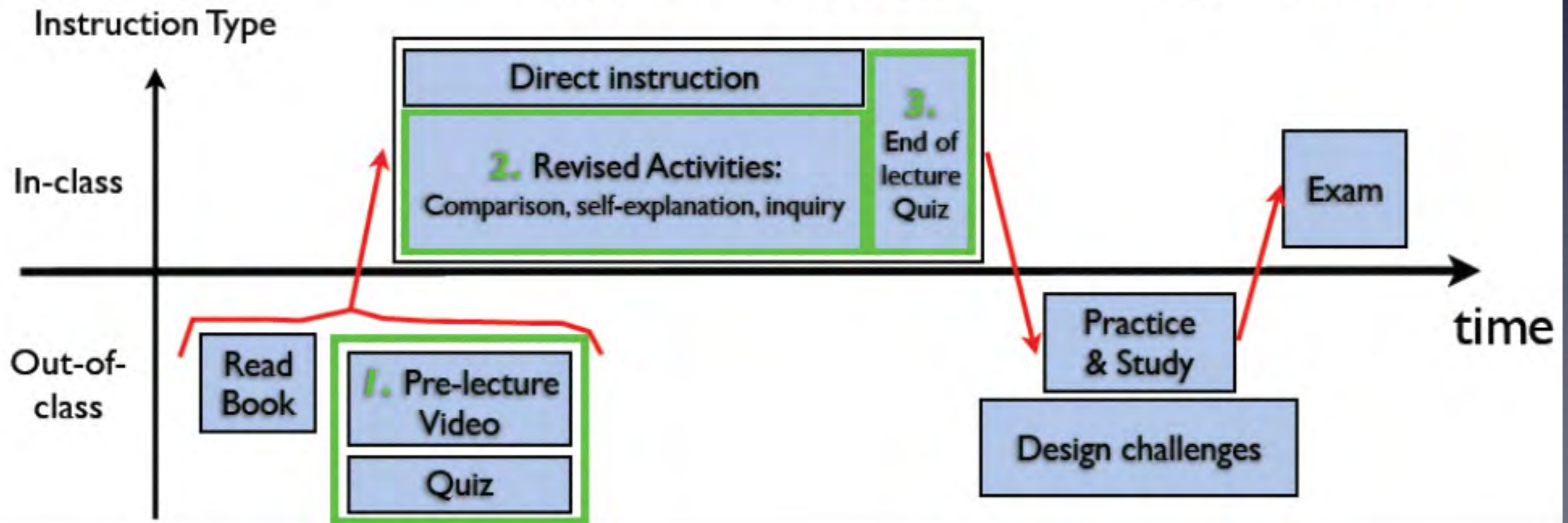
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Focused attention is the:

- A. Ability to attend to or select some information and ignore other information
- B. Ability to perform multiple tasks simultaneously
- C. Ability to perform tasks automatically
- D. Ability to predict where to look for information

# Flipped Instruction

Major Revisions ■





# End-of-lecture quiz

## 21 quizzes

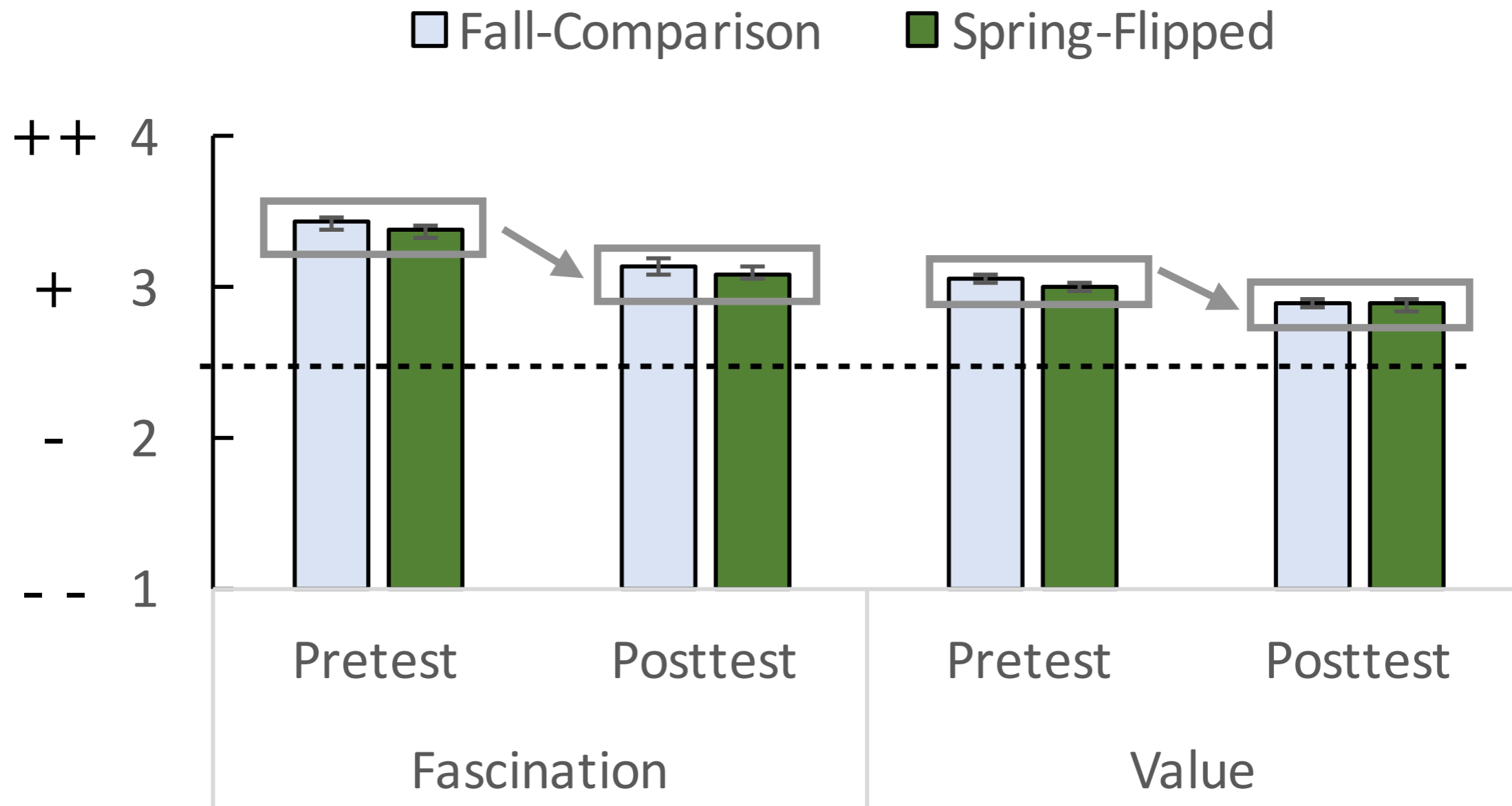
1. What does the Sperling (partial report) Experiment tell us about sensory stores and when we select information?
  - A. We encode a lot of information initially and are able to remember all of it for long periods of time.
  - B. Only a very small amount of information is available initially, and we can remember it for a long time.
  - C. We encode a lot of information initially, but if it is not selected then it is lost.
  - D. The longer the delay between encoding and recall the more we can remember.
2. What type of information does our attentional system select?
  - A. Spatial
  - B. Object
  - C. Both
  - D. Neither
3. Cherry's (1953) dichotic listening experiment was significant as it provided initial evidence for which theory?
  - A. Early selection
  - B. Late selection
  - C. Attenuation theory
  - D. Object based selection
4. Briefly describe the attenuation model. How does it work?

# Assessment

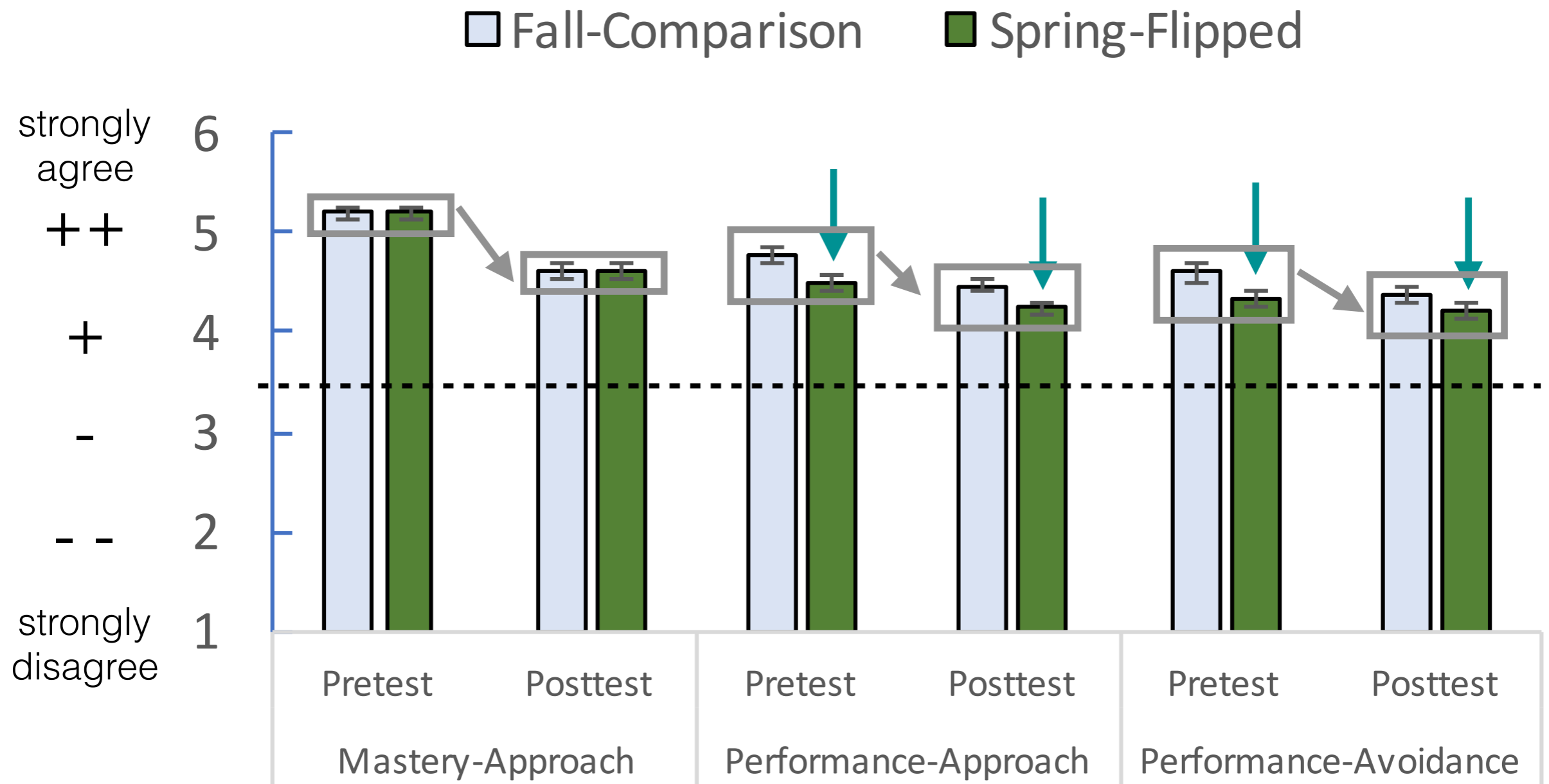
- Motivation and Engagement
  - **Surveys:** interest, value, achievement goals, self-efficacy, theory of intelligence, and grit
  - Participation
- Learning
  - Surveys: study skills (cognitive and meta-cognitive)
  - 3 Exams (35 multiple choice question)
  - Design Challenges



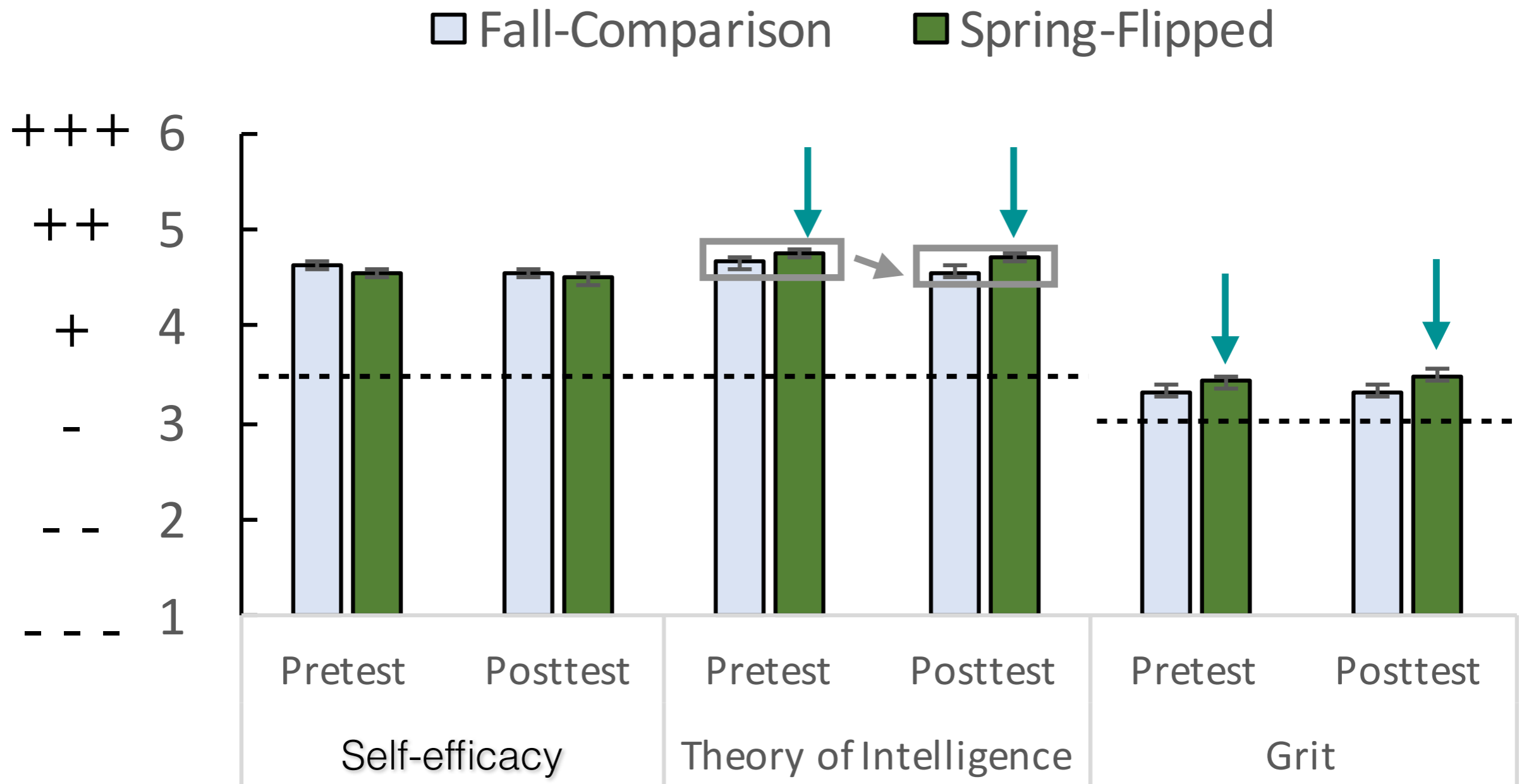
# Preliminary results



# Preliminary results



# Preliminary results





# Motivation Summary

- Decreases in fascination and value pre to post;  
No differences across classes
- Decreases in mastery and performance goals pre to post  
Comparison class reported overall higher endorsement of performance goals
- No differences in self-efficacy;  
Flipped class more strongly endorsed a malleable theory of intelligence and higher grit
- *Were between class differences driven by course structure and expectations or individual differences coming into the class?*

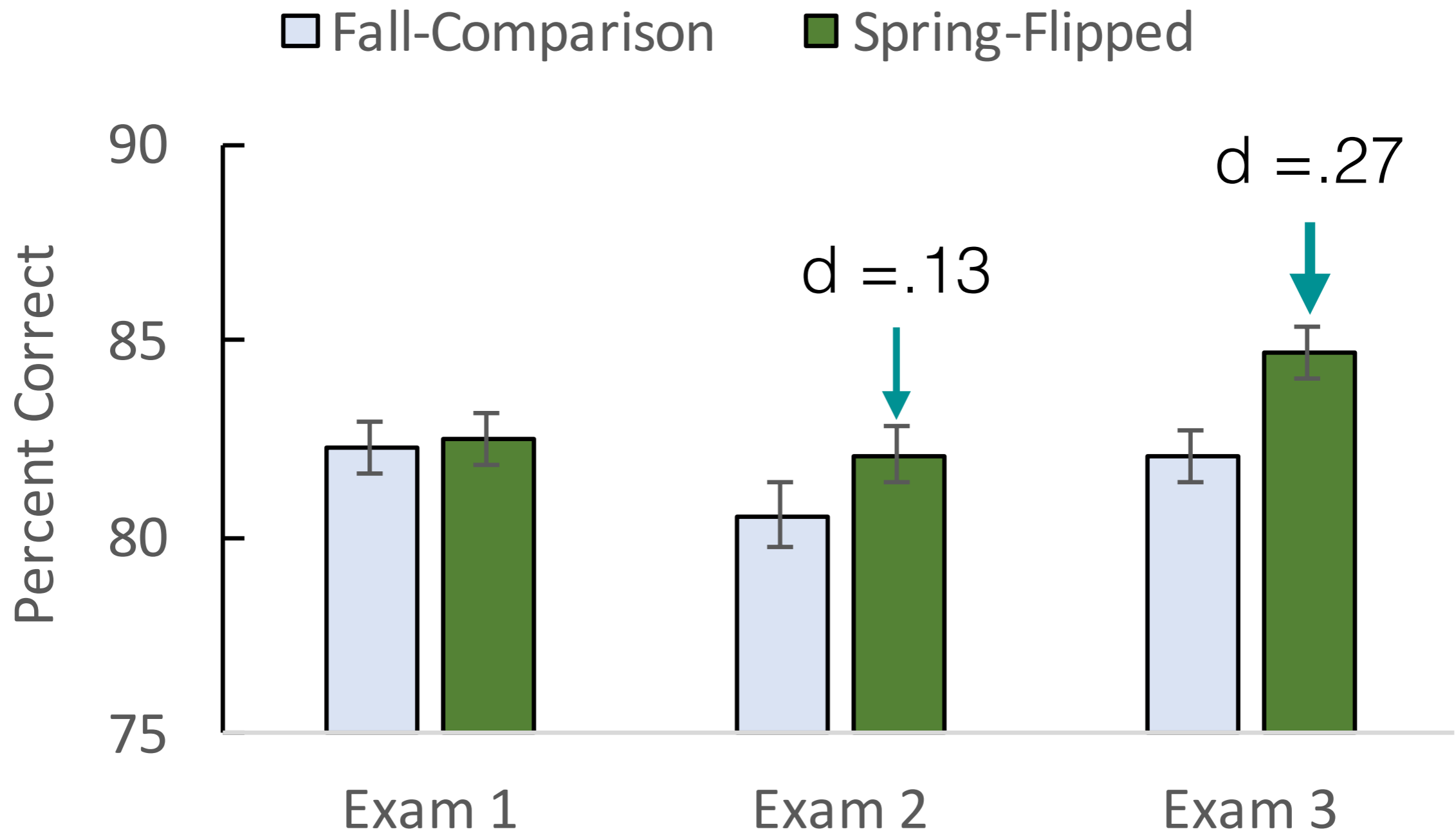
# Assessment

- Motivation and Engagement
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# Assessment

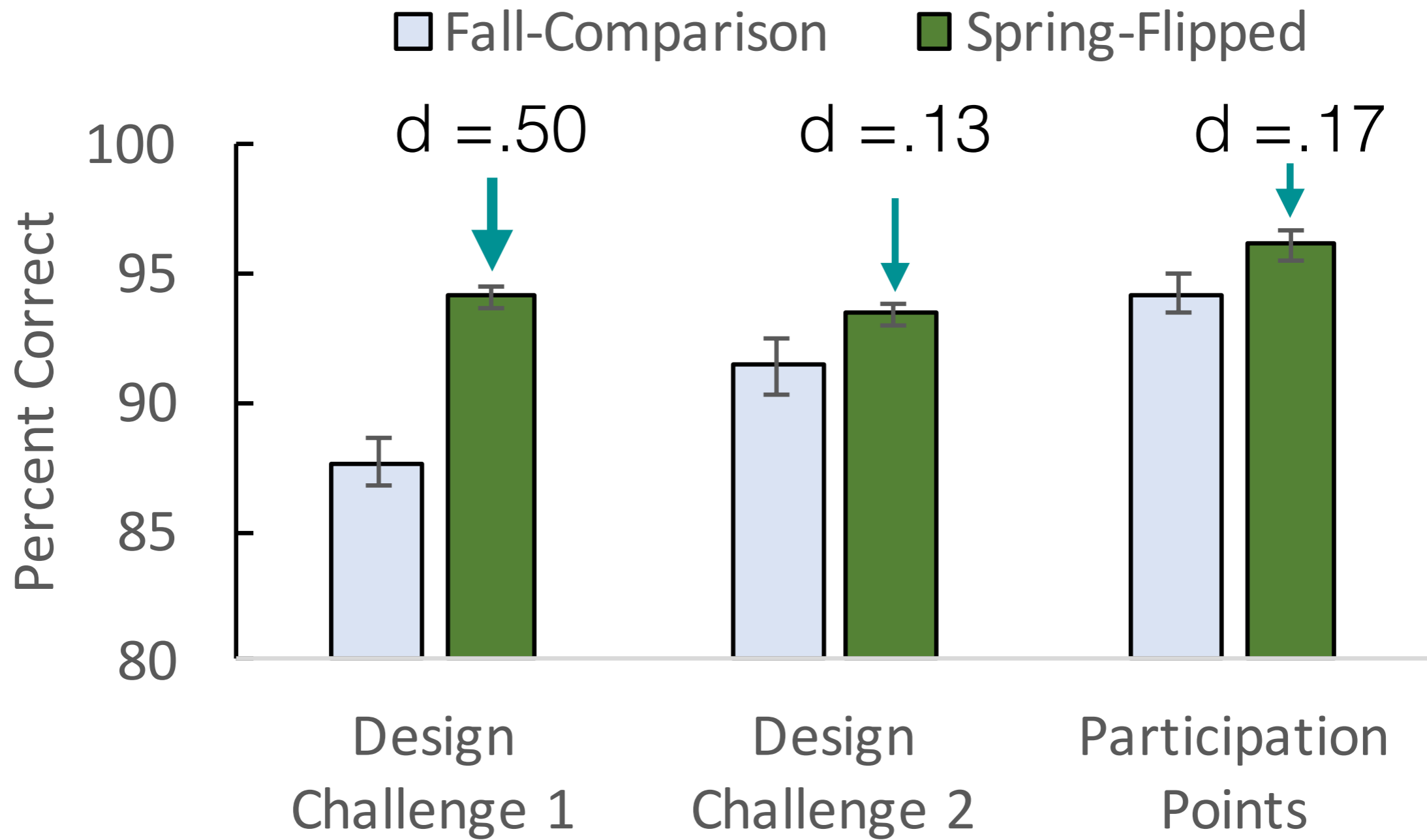
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# Assessment

- Motivation and Engagement
  - Surveys: interest, value, achievement goals, self-efficacy, theory of intelligence, and grit
  - **Participation**
- Learning
  - Surveys: study skills (cognitive and meta-cognitive)
  - 3 Exams (35 multiple choice question)
  - **Design Challenges**





# Learning Summary

- No differences on post self-report survey for cognitive & metacognitive skills
- Gains for the flipped class on the later exams
- Large gain for the flipped class on DC-1 and small gains on DC-2 and participation points

# Next steps

- More analysis...
  - taking into account prior performance and demographics; Propensity Score Matching
  - relations between motivation and learning
- Other measures:
  - in-class inquiry activity near the end of the semester
  - additional motivation, cognition, and metacognition survey items
  - open-ended survey questions: study strategies
- Changes going forward:
  - more quizzes, change grading structure of them?
  - add inquiry component to exam assessment?

# Thank you

## Graduate Teaching Assistants



Cristina  
Zepeda



Brendan  
Barstow



Kelly  
Boden

Aliya Blackwood

## Undergraduate Teaching Assistants

Toyin Ajayi  
Merete Chaplin  
Elisabeth Estes  
Morgan Everett  
Monica Kim  
Gwen Hoeffgen  
Amanda Hopcroft  
Emily Wenz

# Questions?

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