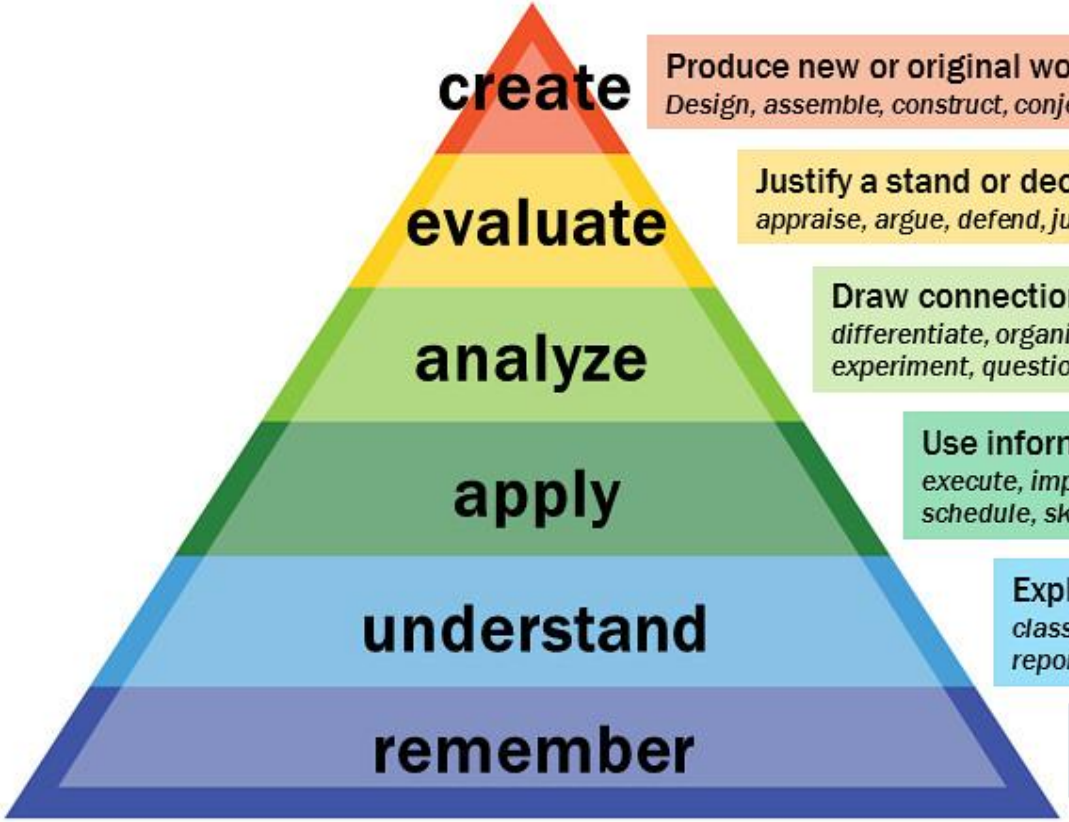
Announcements

- Updated course outline
- Assignment 2 – Active Learning. Deadline: 12th October
- Extra class

Spacing and Testing Effect

Bloom's Taxonomy



Produce new or original work
Design, assemble, construct, conjecture, develop, formulate, author, investigate

Justify a stand or decision
appraise, argue, defend, judge, select, support, value, critique, weigh

Draw connections among ideas
differentiate, organize, relate, compare, contrast, distinguish, examine, experiment, question, test

Use information in new situations
execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch

Explain ideas or concepts
classify, describe, discuss, explain, identify, locate, recognize, report, select, translate

Recall facts and basic concepts
define, duplicate, list, memorize, repeat, state

Testing Enhances the Transfer of Learning

Shana K. Carpenter

Key Concepts

- Encoding vs retrieval
- Testing effect / retrieval practice: retrieving beats rereading for durable learning.
- Transfer: applying what you learned in new contexts (the ultimate goal).
- Three modes of transfer: temporal, test-format, knowledge-domain.

Temporal Transfer

- Tested items remembered better after delays (Carpenter, Pashler, Wixted & Vul, 2008)
- Testing benefit persists up to 9 months (Carpenter, Pashler & Cepeda, 2009)
- Sometimes stronger after a delay than immediately (Coppens, Verkoeijen & Rikers, 2011)

Test Format Transfer

- Cued recall ➔ benefits both same and opposite recall directions (Carpenter, Pashler & Vul, 2006)
- Short-answer practice boosted later multiple-choice & short-answer (Kang, McDermott & Roediger, 2007)
- Free recall enhanced retention across recall, cued recall, and recognition (Carpenter & DeLosh, 2006)

Knowledge Domain Transfer

- Tested passages ➜ helped recall related new content (Chan, McDermott & Roediger, 2006)
- Testing functions supported applying to novel x–y values (Kang, McDaniel & Pashler, 2011)
- Testing bird classification aided transfer to new categories (Jacoby, Wahlheim & Coane, 2010)

Learning concepts and categories: Is spacing the "enemy of induction"?

Kornell, N., & Bjork, R. A.

Key Concepts

- Induction: discovering the general rule by observing specific cases.
- Inductive Learning: Learning general patterns or rules from specific examples.
  - A baby infers the concept “chair” from varied chairs seen at home/school.
  - A junior doctor learns to recognize lung cancer patterns across different X-rays.
  - A student learns an artist’s style from varied paintings (e.g., brushwork, palette).
- Spacing vs. Massing
  - Spacing (Interleaving): Studying examples from different categories mixed together.
  - Massing (Blocking): Studying many examples from the same category all at once.
- Illusion of Fluency
  - Massed practice feels easier in the moment but can mislead about what you’ve truly learned.

Current Study

- Core question: Does spacing (interleaving) help or hurt inductive learning compared with massing?
- Two goals:
  - Measure the size and direction of the spacing/massing effect for induction in an education-relevant task.
  - Compare subjective judgments (what feels better) vs. objective performance.

Experiment 1

- Task: Learn 12 artists' styles from 6 paintings each (landscapes/skyscapes).
- Presentation:
  - Massed: 6 paintings from one artist shown consecutively.
  - Spaced (interleaved): paintings from different artists alternated.
- Testing: Identify the artist of new paintings (forced-choice among 12 names).
- Participants
  - Within-subjects, N=120
    - Each participant saw half the artists massed and half spaced. After study, a brief distractor, then 4 test blocks (new paintings). Also asked which method they thought helped.
  - Between-subjects, N=72
    - one group all massed, another all spaced

Experiment 1

- Spacing beat massing on identifying new paintings by the correct artist.
- Metacognition:
  - 78% performed better with spacing
  - 78% believed massing was as good or better

Experiment 2

- Purpose: Remove the need to recall artist names; test style induction directly
- Test changed: “Is this by a familiar (studied) artist or an unfamiliar artist?” (style recognition)
- New twist: Each target had a distractor painting by a different (non-studied) artist with similar style.
- Participants: N=80. No feedback on this test.

Experiment 2

- Hit rate (correct “familiar artist”) was higher after spaced study than massed
- False alarms (misclassifying distractor as familiar) were similar across conditions.
- Conclusion: Spacing improved induction of style even without name recall.

Spacing vs. Massing: What to use, when?

- Bottom line: For learning patterns from examples (induction), spacing/interleaving usually beats massing—even if massing feels easier.
- Why spacing helps: Interleaving puts different categories side-by-side, sharpening discrimination (noticing the features that really differ).
- When massing can help: If categories are very easy to tell apart, blocking may be fine (or better). If they’re confusable, interleave.

Class Activity

1. Get into groups of 3
2. Pick a topic (e.g., 2nd grade English “tenses”, 3rd grade Science “state of matters”, 10th grade Math “quadratics”). Please focus on just one topic for this activity.
3. Make a 4-week weekly plan: Decide what you will teach each week, how often you will test the students and exactly how.
4. Design a prototype test: Depending on how often you will test your students, create a prototype of each test. Questions can be multiple choice, short answer, matching, very short tasks, etc.
5. Use Bloom’s Taxonomy: Label each question with the Bloom level it belongs to (R = Remember, U = Understand, A = Apply, An = Analyze, E = Evaluate, C = Create).
6. Remember the testing effect means that taking tests (active retrieval) makes learning stick better and more flexible. In your plan, show how you’ll maximize recall and transfer (recall three modes of transfer: temporal, test-format, knowledge-domain.)
7. Please make sure to submit your work before the end of class.