Science of Learning in Action in STEM:
Self-explanation, Distributed Study, and Embedded Questions to Promote Student Learning
Center for Excellence and Innovation in Teaching and Learning

Learning Issue:
Professor wanted students to arrive at class having completed the assigned textbook readings

Prompted Self-Explanation
Constructive learning strategy
Self-monitoring of evolving understanding
- Review new material
- Relate information to prior knowledge
- Provide concrete examples based on new understanding
- Generate questions based on new understanding

Mechanism
- Identification of gaps in learning
- Helps modify flawed, existing mental models

What we did:
Homework reading learning activity (RLA) in an introductory
biology course
- Between-subjects design
- 148 students completed the RLA textbook chapters
- Responded to prompts after each chapter section
- 2 randomly assigned groups:
  - Summarize
  - Self-explain

What we found:
Students in the Self-explanation condition, compared to students in the Summarize condition, performed better on exam questions related to the chapter readings.

Learning Issue:
Professor wanted students to study and learn a number of facts and basic concepts prior to exam.

Distributed, Retrieval Practice
Spaced, repeated study over a number of study occasions
- Waiting a period of time between study sessions when there is no immediate repetition generates a new learning event
- Retrieval practice (quizzing) during study promotes learning
  - Indirect:
    - Learn from feedback
    - Guides further study
  - Direct:
    - Active retrieval from memory

What we did:
Flashcard study in an introductory biology course
- Within-subjects design
- 176 students completed flashcard study sessions on each of the 4 days leading up to an exam
- 2 randomly assigned groups
  - Spaced/massed
  - Massed/spaced

Learning Issue:
Professor wanted students to engage in active learning during class in an effort to promote learning.

Embedded Questions During Lecture
Retrieval practice (quizzing) during lecture promotes learning
- Indirect:
  - Learn from feedback
  - Guides further study
- Direct:
  - Active retrieval from memory

What we did:
In-class clicker study in an energy and environment chemical engineering course
- Within-subjects design
- 99 students attended all course sessions using clickers for embedded questions during lecture
- Modeled after Eric Mazur’s learning strategy:
  - Present material in class
  - Pose a multiple-choice question
  - Think about it ~30 seconds
  - Click in response to a question
  - Discuss with peers
  - Click again

What we found:
Question presentation technique varied for each class.

Mean Transfer Exam Score by Condition
Students performed better on exam transfer questions when quizzed during lecture.
Of the three quizzed conditions, students performed best when the clicking was removed.