Can we change students' study behavior when they are studying for exams?

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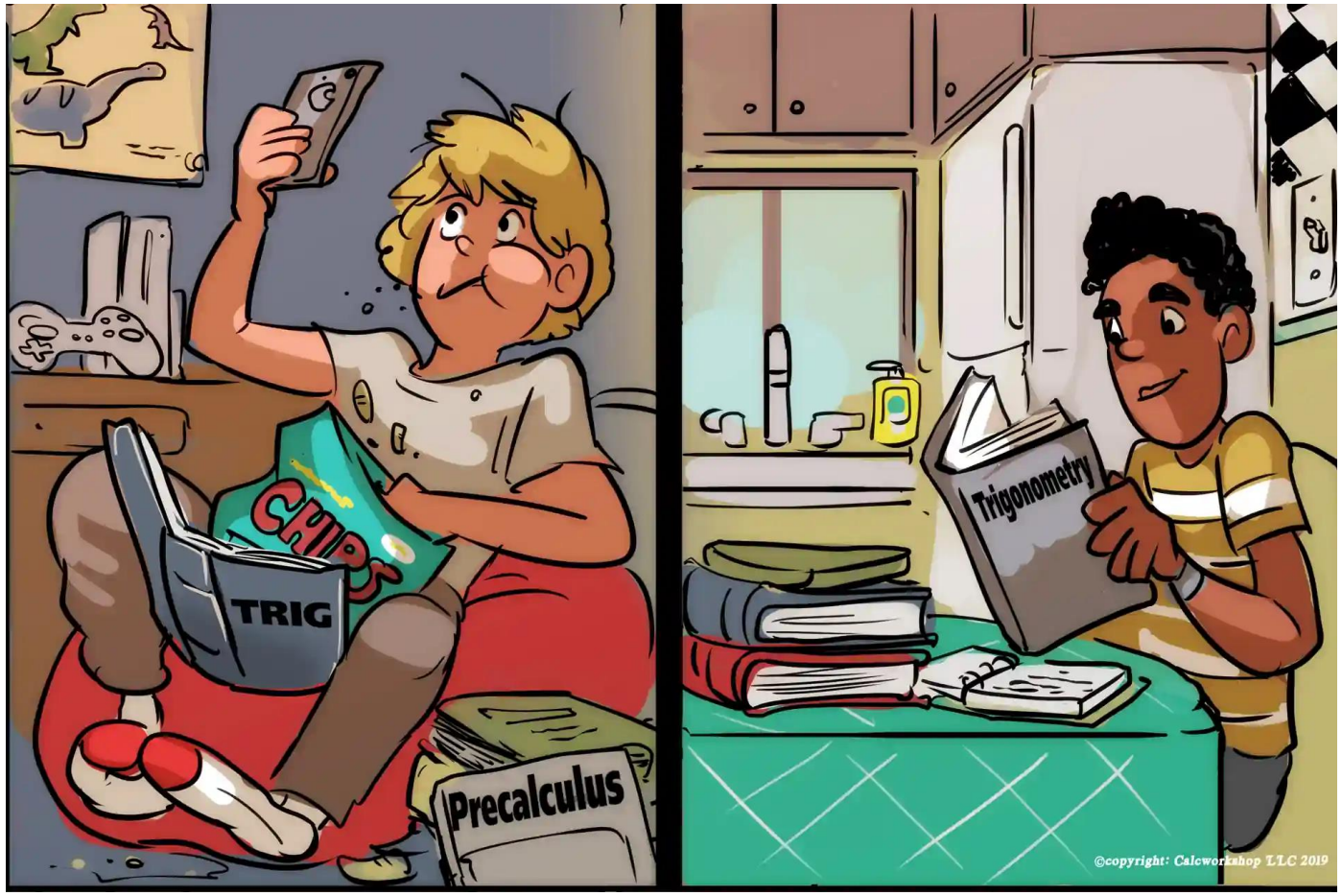
Study Habits

-The **study strategies** students use to study for exams

-The amount of **time** students study and how they manage that time

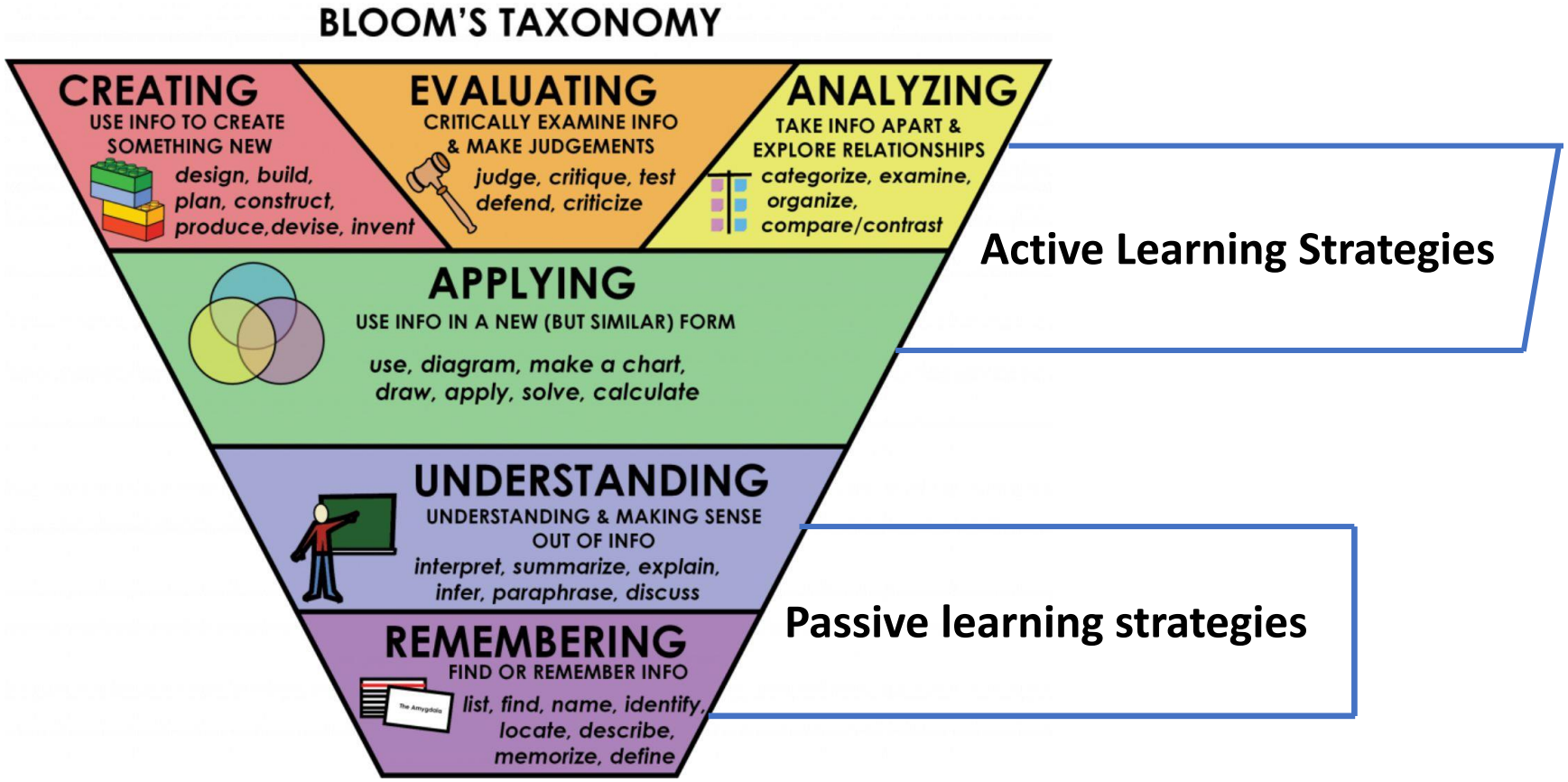
-The **environment** in which students study



Study Habits are related to student performance

What do we want students to be able to do after studying/learning the respective topics of class?

Generate knowledge or skills that are robustly integrated with related knowledge and easily accessible



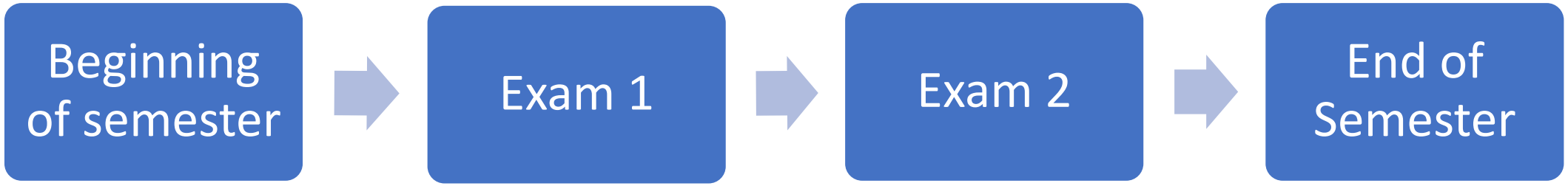
From Cognitive Science Literature

Learning Techniques	Description	Utility
Highlighting/underlining	Marking potentially important portions of to-be-learned materials while reading	Low
Rereading	Restudying text material again after an initial reading	Low
Summarization	Writing summaries (of various lengths) of to-be-learned texts	Low
Keyword mnemonic	Using keywords and mental imagery to associate verbal materials	Low
Imagery for text	Attempting to form mental images of text materials while reading or listening	Low
Elaborative interrogation	Generating an explanation for why an explicitly stated fact or concept is true	Moderate
Self-explanation	Explaining how new information is related to known information, or explaining steps taken during problem solving	Moderate
Interleaved practice	Implementing a schedule of practice that mixes different kinds of problems, or a schedule of study that mixes different kinds of material, within a single study session	Moderate
Practice testing (often called retrieval practice)	Self-testing or taking practice tests over to-be-learned material	High
Distributed practice	Implementing a schedule of practice that spreads out study activities over time	High

Note: Table from Dunlosky et al., Cog Sci Review of Effective Learning Techniques for Students, Psychological Science in the Public Interest, 2013

Research Questions at Utah

Study 1: What types of self-directed study behaviors do students enrolled in General Chemistry I use when studying for exams and what is the effect on their exam performance?



Prior Chemistry Knowledge

Study Habits (Exam 1)

Study Habits (Exam 2)

Final Exam Week

Study 2: Do students who participate in weekly study-strategy sessions change their self-directed study behaviors that they use when studying for exams?

All study procedures were approved by the University of Utah Institutional Review Board (IRB). Students consented to allow researchers to access survey responses, course grades, and demographic/academic records obtained from the Office of Budget and Institutional Analysis (OBIA) for the purposes of this research study.

Which learning strategies do students use the most to study for the GC1 exams 1 and 2?

Study Strategy		Exam 1		Exam 2	
	Type	N	%	N	%
Re-worked homework questions	**Active**	**269**	**69**	**247**	**64**
Re-read lecture slides or class notes	**Passive**	**249**	**64**	**257**	**66**
Explained concepts to myself or others	**Active**	**190**	**49**	**184**	**47**
Attended the Review Session	**Mixed**	**179**	**46**	**181**	**47**
Paraphrased or outlined class notes (includes creating a study guide or writing	Active	140	36	102	26
Re-worked weekly graded homework sets	Active	126	32	107	27
Re-watched lecture videos	Passive	102	26	136	35
Re-read textbook	Passive	97	25	105	27
Made my own diagrams or comparison tables from lecture notes	Active	74	19	83	21
Re-wrote your class notes word for word	Passive	46	12	33	9

-There are four top strategies that students use, and they are a combination of passive and active strategies.

-in Study 1, the top four strategies did not change from exam 1 to exam 2.

Study 1 results: Which learning strategies predict student performance on exams 1 and 2 in a GC1 course?

Prior Assessment or Learning Strategy	Effect on Exam	Exam 1	Exam 2
		p	*p*
Chemistry Pre-assessment	Positive	**<0.001**	**<0.001**
Class days missed in exam period	Negative	**0.001**	**0.024**
Explained concepts to myself or others	Positive	**0.001**	**0.006**
Re-worked weekly graded homework	Positive	**0.010**	**---**
Attended the Review Session	Positive	**---**	0.073
Re-wrote your class notes word for word	Negative	**<0.001**	---
N_{total} (Exam 1) = 541 N_{total} (Exam 2) = 470			

Results (robust over both exams):

- **Class days missed for that exam unit** negatively affected exam performance (~1%/day)
- From the top four strategies students used, **explaining concepts** positively affected exam performance (3-5% if used)
- Finding from Studies 1 and 2: If a passive strategy affected exam performance, it was always a negative effect.
- Finding from Studies 1 and 2: If an active strategy affected exam performance, it was always a positive effect.

Study 1 results: Which study habits predict student performance on exams 1 and 2 in a GC1 course?

Prior Assessment or Study Habit	Effect on Exam	Exam 1	Exam 2
		p	***p***
Chemistry Pre-assessment	Positive	**<0.001**	**<0.001**
Class days missed	Negative	**0.004**	**0.024**
% Exam Study Time using active strategies	Positive	**0.003**	**0.028**
% Time distracted Studying for Exams	Negative	**0.005**	**0.001**
Number of days studied for Exams	Negative	**<0.001**	0.943

N_{total} (Exam 1) = 537 N_{total} (Exam 2) = 468

Results (robust over both exams):

- Findings from both Studies 1 and 2: Students who spent all of their study time using active strategies scored **7.0 percent** and **4.0 percent higher** on exams 1 and 2, respectively, then those students who spent none of their study time using active strategies.
- Finding from both Studies 1 and 2: Students who reported being **distracted 50%** of the time when studying scored about **5 percent lower** on exams 1 and 2, respectively, than students who reported not being distracted when studying.

Key Findings from Utah Study

1. Students used a combination of active and passive strategies
   - Top four strategies: **re-working homework problems**, **re-reading lecture slides or class notes**, **explaining concepts to myself and others**, and **attending the review session.**

2. Not all active strategies affected performance, but if they did affect performance, the effect was positive.
   - The active strategies **explaining concepts** and **re-working homework** **improved** students' performance by **(4.8 – 3.2) %** and **(4.0%; exam 1 only)**, respectively.

3. Not all passive strategies affected performance, but if they did affect performance, the effect was negative.
   - The passive strategy **re-write your class notes for word** **decreased** performance for exam 1 by **(9.5%).**

4. % of Exam-study time spent using active strategies **increased** performance
   - Students who spent all of their study time using active strategies scored **7.0 percent** and **4.0 percent higher** on exams 1 and 2, respectively, then those students who spent none of their study time using active strategies.

5. % of time distracted while studying **decreased** performance
   - Students who reported being **distracted 50%** of the time when studying scored about **5 percent lower** on exams 1 and 2, respectively, than students who reported not being distracted when studying.

Key Findings from Washington University Study (Intro Biology 1)

1. The top four strategies that students use to study for IB1 are: **re-reading lecture notes, Re-working problem sets, re-working old exams/quizzes, and self quizzing.**

2. Study strategies that significantly affected exam performances: **re-working problem sets, self-quizzing, explaining concepts, attending review sessions.**
   - All positively affected exam performance.

3. Study-time management behaviors that significantly affected exam performances
   - **Number of active strategies used, % study time using active strategies, and total study hours** positively affected exam performance.
   - **Percent time distracted while studying and # classes missed in exam unit** negatively affected exam performance.

From Cognitive Science Literature

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Highlighting/underlining	Marking potentially important portions of to-be-learned materials while reading	Low
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Interleaved practice	Implementing a schedule of practice that mixes different kinds of problems, or a schedule of study that mixes different kinds of material, within a single study session	Moderate
Practice testing	Self-testing or taking practice tests over to-be-learned material	High
Distributed practice	Implementing a schedule of practice that spreads out study activities over time	High

Note: Table from Dunlosky et al., Cog Sci Review of Effective Learning Techniques for Students, Psychological Science in the Public Interest, 2013

Study Strategy Training Sessions

- Introduce to a study strategy
- Practice the study strategy
- Work on problems related to class material, using that strategy

- Fall 2022 in a General Chemistry course

- Learning Assistants (LA's) ran the optional weekly sessions.

- Research study – comparing study strategies used and effect on performance for students who attended the ST sessions compared to those who did not; taking attendance to check "Dosage" effect

The Learning Scientists
https://www.learningscientists.org/

Week Two	Week Four	Week Five	Week Six	Week Seven	Week Eight	Week Nine	Week Ten	Week Eleven	Week Twelve	Week Fourteen
Retrieval Practice	Elaboration/ Self-explanation	Spaced Practice		How to Study	Dual Coding	Elaboration/ Self-Explanation II	Concrete Examples		Inter-leaving	Review of Study Strategies
Atomic Structure and Mass	Electronic Config-urations/ Periodic Trends	Chemical Compo-sition/ Intro to names and Formulas of Single Com-pounds	Exam 1	Lewis structures	Valence Bond Theory/ Molecular Orbitals Theory	Chemical Equations and Intro to Stoichio-metry/ Stoichio-metry and Limiting Reactants	Thermo-chemistry	Exam 2	Gases	Liquids, Solids, and Inter-molecular Forces

Predictor	Exam 1 (%)		Exam 2 (%)		Final (%)	
	Effect on Exam	**P-value**	**Effect on Exam**	**P-value**	**Effect on Exam**	**P-value**
Prior Chemistry Knowledge	Positive	**<0.001**	Positive	**<0.001**	Positive	**<0.001**
Class days missed	Negative	**<0.001**	Negative	**<0.001**	Negative	**<0.001**
Conscientiousness (factor 2)	Positive	**0.031**	Positive	0.203	Positive	0.203
Low attendance (1-2)	Positive	0.370	Positive	0.443	Positive	0.443
Medium attendance (3-4)	Negative	0.966	Positive	0.947	Positive	0.947
High attendance (5-9)	Positive	0.341	Positive	**0.014**	Positive	**0.014**
N(Exam 1) = 581		**N(Exam 2) = 556**		**N(Final) = 523**		

Did students who attend do better?

High Attendance:

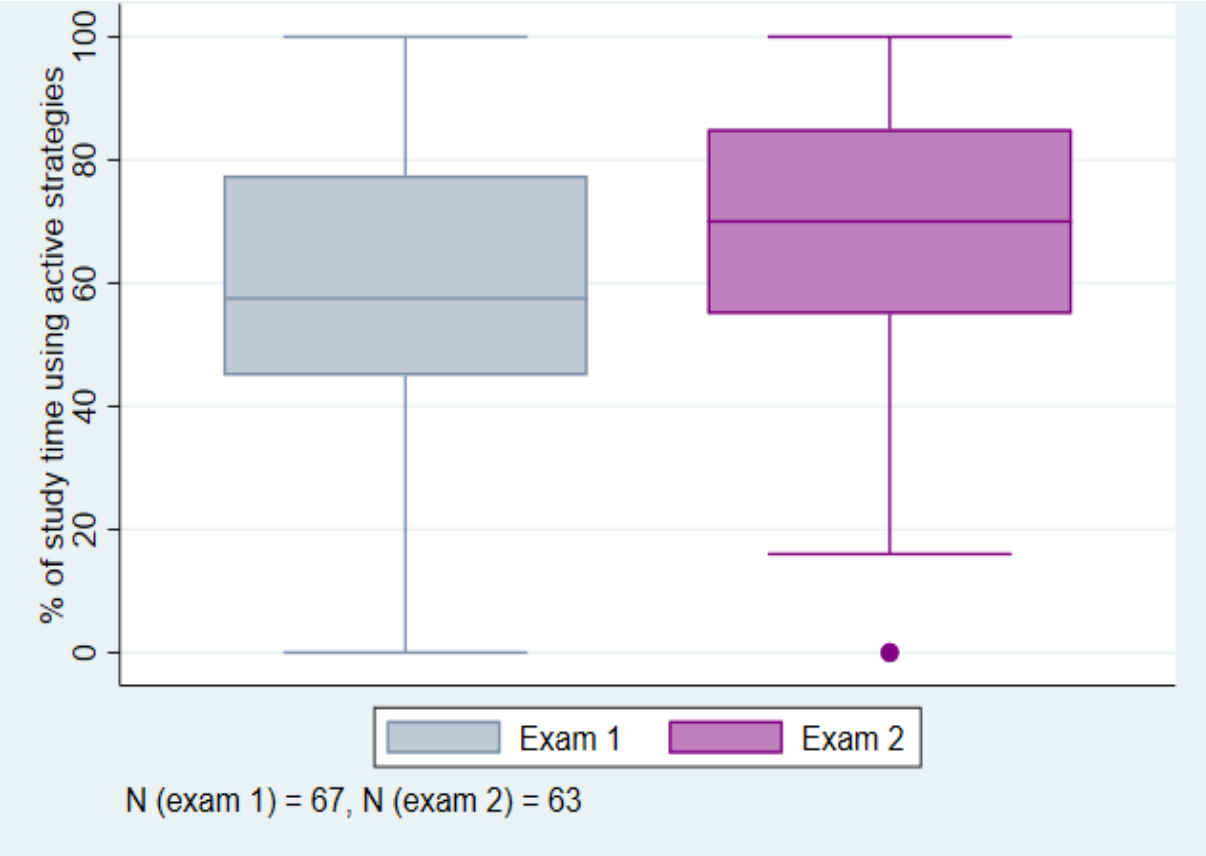
Scored an average of **5.4% higher** on Exam 2 and the Final exam compared to students who did not attend any of the sessions

Exam 2		Low Attendance (n=346)		Medium Attendance (n= 63)		High Attendance (n= 44)	
Study Strategy	Type	N	%	N	%	N	%
Practice Quizzes	Active	273	**79**	50	**79**	35	**80**
Re-worked homework problems	Active	239	**69**	46	**73**	33	**75**
Explained Concepts to myself and others	Active	158	**46**	37	**59**	27	**61**
Re-read lecture notes or textbook	Passive	141	**41**	28	**44**	15	**34**
Attended the Review Session	Mixed	91	26	33	52	31	**71**
Re-wrote lecture notes	Passive	41	12	9	14	6	14

Did they change their strategies?

NO!

High Attendance
% Time using Active Strategies



They did change their Exam-study Time management behavior

High Attendance:

Increased their % of exam study time where they use active strategies.

Exam 1 mean %: 59%
Exam 2 mean %: 67%

No Attendance:

No change in their % of exam study time using active strategies

Exam 1 mean %: 61%
Exam 2 mean %: 61%

Key Findings from Utah Study

1. Conscientiousness did not affect exam scores robustly

2. Students need to practice these strategies consistently over the semester
   - High-attendance students outperformed no, low and medium-attendance students on Exam 2 and the final

3. Hard to get students to change their use of study strategies
   - No difference between no, low, medium, high attendees

4. Exam-study time management behavior was more changeable
   - High attendance students increased their use of active strategies when studying for an exam

Implications for Instructors

- Teach students different active strategies
  - Think about which ones would be effective for your exams/assessments
  - Teach them to use these strategies correctly by modeling in class, having them practice in class and give feedback on their use of the strategies
    - e.g., When doing a clicker question, have students explain their answers (ask for their reasoning), then explicitly state your approach to answering the question and self-explain your reasoning out loud. (Note: This also gives you an opportunity to add the rationale for why certain strategies are effective or provide advice about carrying them out.)
    - e.g., Have them work in small groups in class where they have to explain concepts and their solutions to each other
  - Give homework/assignments that require students to use these active strategies
    - e.g., To encourage self-explanation/elaboration, have them explain their solutions and connect their solutions to the concepts
    - e.g., to encourage dual-coding, have them draw diagrams and explain the key points of the diagrams in writing and why those key points are important
  - Tell students that use of passive strategies can have a negative effect on performance
    - Teach them how to turn some of these passive strategies into active ones
    - e.g., instead of re-reading the slides, have them pull out key ideas/equations and connect them to the concepts

Implications for Instructors

- Study-time Management behaviors might be easier to change than actual use of learning strategies
  - Tell students that % time using active study strategies while during homework etc. leads to improved performance
  - Model this for them by having most of your class be active learning

- Distraction/multitasking is detrimental to performance
  - Encourage students to stay focused during studying
    - e.g., Discuss the Pomodoro technique, which involves working in focused intervals with short breaks interspersed between them
    - e.g., help students set up a weekly schedule for themselves using time blocking, where students allocate dedicated blocks of time for specific tasks or subjects, which helps create a structured study schedule and can help students to focus attention on each task
    - e.g., Discuss their study environment and if it could lead to distraction
  - Provide voluntary, structured study sessions such as peer-led sessions or less structured as small-group-oriented office hours

- Encourage and instruct students on effective study behaviors consistently throughout the semester

Thank you for listening.

Questions/Comments?