What does Cognitive Psychology say about Effective Study Habits? And what study habits do Students use in Introductory Science Courses?

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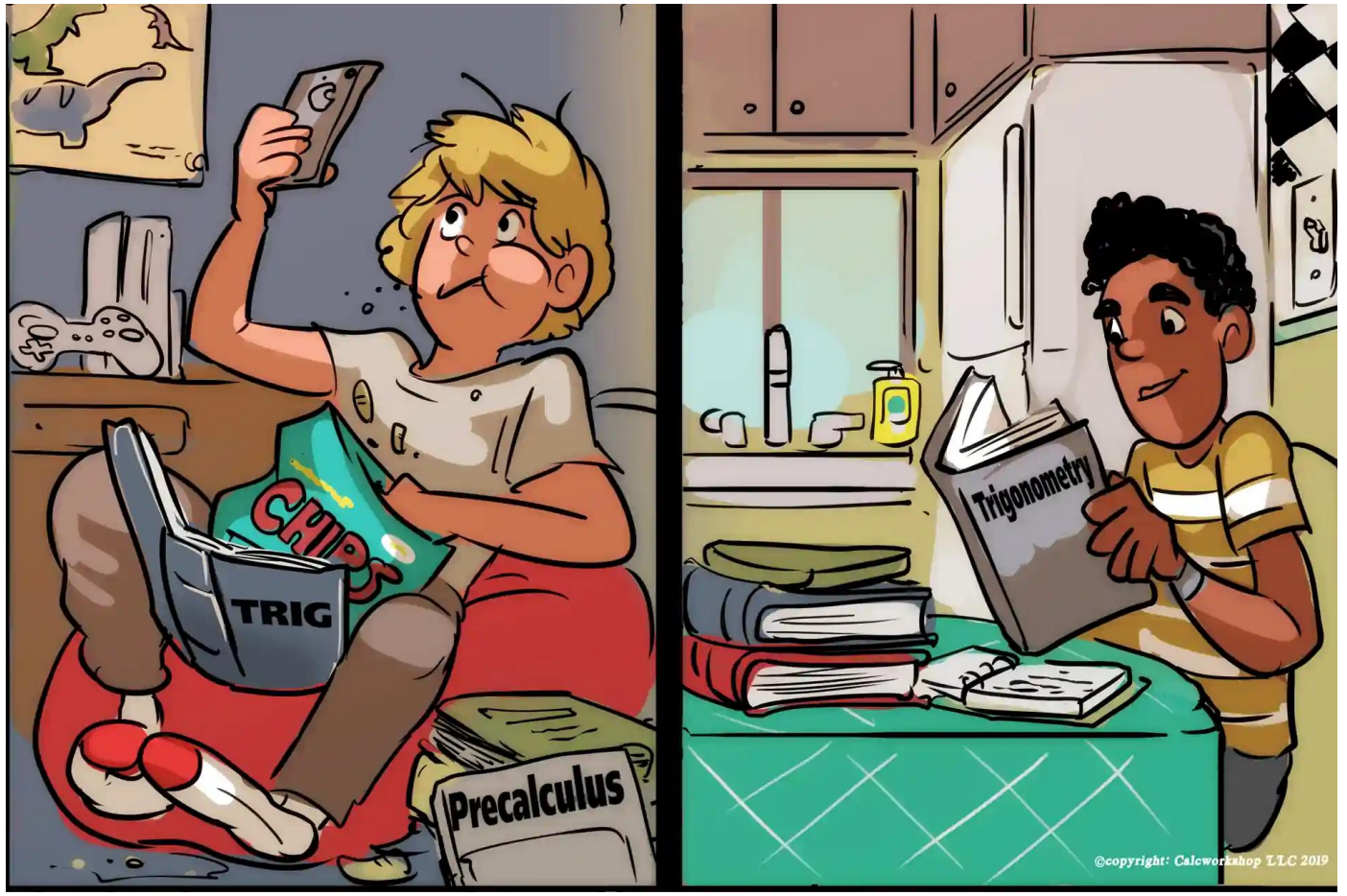
Study Habits

-The **study strategies** students use to study.

-The amount of **time** that students study

-The **environment** in which students study



Study Habits are related to student performance

Walck-Shannon. E. M, et.al. CBE—Life Sciences Education (2021)
Rowell. S. F, et.al. Teaching of Psychology (2020)

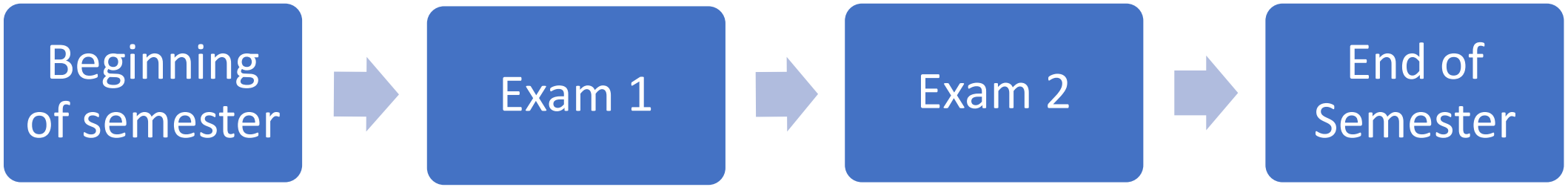
From Cognitive Science Literature

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	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 Question at Utah

What types of self-directed study behaviors do students enrolled in General Chemistry I have and what is the effect on their performance?



Chemistry Pre-Assessment

Study Habits (Exam 1)

Study Habits (Exam 2)

Final Exam Week

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 mastering chemistry problem questions	**Active**	**269**	**69.3299**	**247**	**63.65979**
Re-read lecture slides or class notes	**Passive**	**249**	**64.17526**	**257**	**66.23711**
Explained concepts to myself or others	**Active**	**190**	**48.96907**	**184**	**47.42268**
Attended the Review Session	**Mixed**	**179**	**46.13402**	**181**	**46.64948**
Paraphrased or outlined class notes (includes creating a study guide or writing	Active	140	36.08247	102	26.28866
Re-worked weekly graded homework sets	Active	126	32.47423	107	27.57732
Re-watched lecture videos	Passive	102	26.28866	136	35.05155
Re-read textbook	Passive	97	25	105	27.06186
Made my own diagrams or comparison tables from lecture notes	Active	74	19.07216	83	21.39175
Re-wrote your class notes word for word	Passive	46	11.85567	33	8.505155

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

-The top four strategies did not change from exam 1 to exam 2.

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**	---
Exam 1 (%)	Positive	---	**<0.001**
Class days missed	Negative	**0.001**	**0.024**
Re-wrote your class notes word for word	Negative	**<0.001**	---
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

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 stepwise regressions, **only the listed strategies in the table** predicted performance on the exams.
- From the top four strategies students used, **explaining concepts** positively affected exam performance (3-5% if used)

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**	-----
Exam 1 (%)	Positive	**---**	**<0.001**
Class days missed	Negative	**0.004**	**0.024**
% Time distracted Studying for Exams	Negative	**0.005**	**0.001**
% Exam Study Time using active strategies	Positive	**0.003**	**0.028**
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):

- 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.

- 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.

Key Findings from Utah Study

1. There top four strategies that students use to study for GC1 are: **re-working mastery in chemistry problems**, **re-reading lecture slides of class notes**, **explaining concepts to myself and others**, and **attending the review session.**

2. The active strategies **explaining concepts** and **re-working weekly graded homework improve** students' performance by **(4.8 – 3.2) %** and **(4.0%; exam 1 only)**, respectively. The passive strategy **re-write your class notes for word decreased** performance for exam 1 by **(9.5%).** From the top four strategies students used to study, explaining concepts to myself and others distinctly predicted of exam performance.

3. 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.

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

Study Skills Intervention

- Optional weekly Study-Techniques Sessions (this fall 2022; Gen Chem 1)
  - Run by trained upper-level peer leaders (who are connected to the course)
- Session Agenda (example; different study-technique (ST) topic each week)
  - Before the session: Learn about dual coding at the Learning Scientists Blog - Learn How To Study Using... Dual Coding — The Learning Scientists
    - We write tips for the peer leaders for the session; practice weekly with peer leaders
  - Attendance (2 min)
  - Part I: Intro about the ST topic (5 minutes)
    - Introduce students to the idea of dual coding. Dual coding is the idea that using both visual and verbal information aids in learning. Evidence shows that memory for some verbal information is enhanced if a relevant visual is also presented or if the learner can imagine a visual image to go with the verbal information. Instead of focusing on one or the other, we want to use them together. Go back and forth, comparing the words to the pictures.
    - Show students the brief video (from website) and PowerPoint (adapted from website) on Dual Coding
  - Part II: Practice dual coding for MO Theory (20 minutes)
    - Current course topic of the week, practice technique on problems like homework problems in small groups
- Research study – comparing students who attend the ST sessions compared to those who did not; taking attendance to check “Dosage” effect

Implications for Instructors

- Encourage students to use more active study strategies
  - Ask students to turn in the output of the strategy as a low-stakes assignment.
    - To encourage self-explanation, you could ask students to turn in a short video of themselves verbally explaining a concept for credit.
    - To encourage practice quizzing, try to publish or reopen quizzes near exam and ask students to complete them for credit.
- Teach students to use active strategies correctly
  - Model those strategies during class
    - When doing a clicker question, 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.)
    - Remind students during class to use a strategy. Prompting students to explain their reasoning to their neighbors or themselves during a clicker question helps shifts students' conversations toward explanation (Knight *et al.*, 2013).
- Encourage students to stay focused during studying
  - Provide voluntary, structured study sessions
    - Could include highly structured peer-led team-learning sessions during which students work through a packet of new questions (Hockings *et al.*, 2008; Snyder *et al.*, 2015) or more relaxed sessions during which students work through problems that have already been provided (Kudish *et al.*, 2016).

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

Group members and Collaborators

Current Group Members

- Graduate Students
  - **Lori Laguerre**
  - Hector Torres
- Undergraduate Researchers
  - Ray Quintus-Bosz
  - Maria Munoz
  - Olivia Schmitz
  - Mark Jareczak (REU; Wash U)

Collaborators

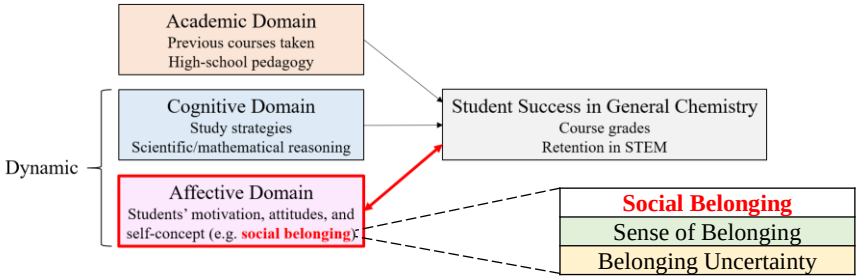
- Center for Science and Mathematics Education (CSME; Utah)
  - HHMI UPSTEM project
- Center for Integrative Research on Cognition, Learning, and Education (CIRCLE; Washington University in St. Louis)
  - Peer Led Team Learning (PLTL) project
  - Classroom Inclusivity and social belonging project (HHMI)
  - Concept-building Approach project
  - Social Network Analysis (HHMI)
- Inclusive STEM Teaching Project (Multi-institutional NSF Grant)
  - Faculty/Future Faculty online Inclusive Teaching program
- Josh Edwards, Dept of Chemistry, Texas A&M (alumnus of group)

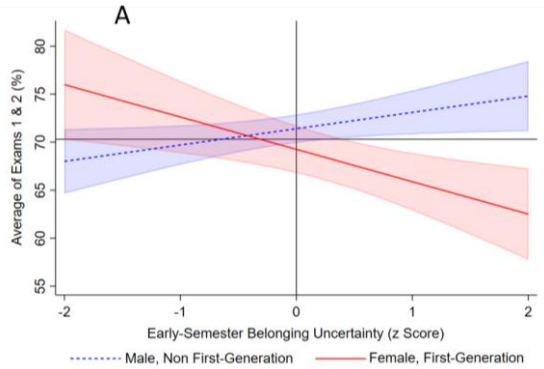
Group Website: https://chem.utah.edu/directory/frey/research-group/

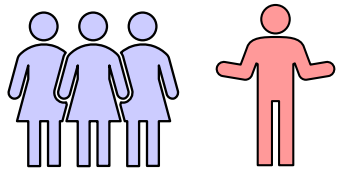
Thank you for listening.

Questions/Comments?

Social Belonging and Inclusive Learning Environments





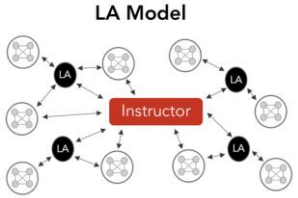


Projects:

- Belonging in UofU general chemistry, organic chemistry, introductory physics
- Belonging in SLCC introductory biology

Peer-Assisted Collaborative Learning

Peer Leaders include roles of LA, SI, PLTL, and undergraduate TA. We are looking at Learning Assistants (LAs) who facilitate discussions among groups of students in classroom settings to encourage active engagement. Our group studies LA implementation and their effect on classroom inclusivity.

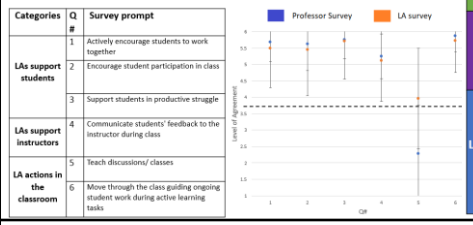


Projects:

- UofU faculty LA implementation in STEM
- UofU LA course inclusivity in STEM

Study methods used

- Survey
- Interviews



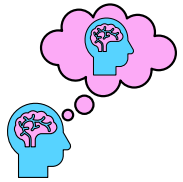
Categories	Q #	Survey prompt
LAs support students	1	Actively encourage students to work together
	2	Encourage student participation in class
	3	Support students in productive struggle
LAs support instructors	4	Communicate students' feedback to the instructor during class
LA actions in the classroom	5	Teach discussions/ classes
	6	Move through the class guiding ongoing student work during active learning tasks

LAs effect on students (61% of responses)	LAs act as a peer mentor	LAs encouraged students by acting as a peer and providing help with course material.
	LAs support students in productive struggle	The quote includes the words "productive struggle"
LAs effect on professor (9% of responses)	Teaching team learns from LA	LAs provide information that they learned in their pedagogy course to enhance teaching methods for the teaching team(professors, TAs, LAs, and SI leaders)
LA model affects on course (31% of responses)	LAs help instructor implements active learning	Having LAs in the course provides the needed resources needed to involve active learning in the class setting
	LAs help instructor to incorporate group work	The use of LAs provided additional resources needed to facilitate group work in the classroom setting

Cognition and Metacognition

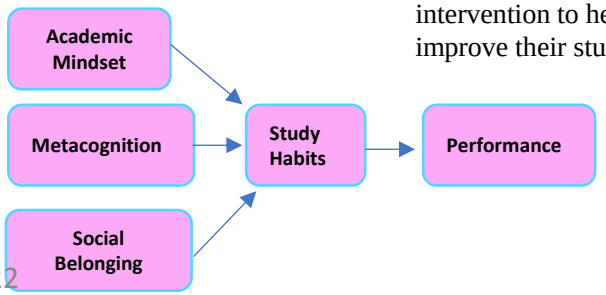
Research Questions:

1. What types of self-directed study behaviors do STEM students have and what is the effect on their performance?
2. What effect does academic mindset have on self- directed study behaviors of STEM chemistry students?
3. What effect does social belonging have on self-directed study behaviors of STEM students?



Purpose

Develop a metacognitive intervention to help students improve their study habits.



Projects:

- Study Habits in UofU general chemistry, organic chemistry
- Study Habits in SLCC introductory biology

Faculty development

With an ever-changing student demographic, instructors often look for new strategies in which they may help to build an equitable learning environment so that all students may succeed in their course.

Projects:

- Multi-institution on-line faculty development course with local learning communities (ISTP)
- UofU and SLCC faculty-learning community

Research tools and skills we use:

- Survey instruments
- Observational instruments
- Cognitive and social psychology
- Quantitative and qualitative analysis

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