Teaching Students How to Succeed in Your Course

Spring 2023
Warm up

Part I. Strategies

● What study strategies do you think are most effective?
● What study strategies do you think your students use?
Warm up

Part I. Strategies

● What study strategies do you think are most effective?
● What study strategies do you think your students use?

Part II. Studying FAQ

● Pgs 3-4 has a FAQ adapted from Meaders, 2021. Could something like this be useful for your students (if tailored for your class)?
Rodriguez et al. (2018): Big Picture

1. Challenge: Persistent achievement gaps in STEM courses between historically Under-Represented Minorities (URM) students and non-URM students.
   ○ Despite work and attention to improving classroom instruction
   ○ Largely ignoring how URM and non-URM students study outside of class

1. Intervention: Spacing and self-testing are two study strategies that have been shown to be effective in laboratory settings
   ○ But little work has shown the effectiveness of these strategies in real classes
Attempts to decrease performance gaps by modifying class time


Attempts to decrease performance gaps by modifying class time


Attempts to decrease performance gaps by modifying class time


“Achievement gap” definition in this article (retention):

% of students who entered college (in 2004) who wanted to graduate as STEM majors who did so within 6 years:

- 43% of White students
- 52% of Asian students
- 22% of Latino/a students
- 25% of African American students
- 25% of Native American students

Overall trends of attrition, STEM vs non-STEM, within 5 yrs:

1. Challenge: Persistent achievement gaps in STEM courses between historically Under-Represented Minorities (URM) students and non-URM students.
   ○ Despite work and attention to improving classroom instruction
   ○ Largely ignoring how URM and non-URM students study outside of class

1. Intervention: Spacing and self-testing are two study strategies that have been shown to be effective in laboratory settings
   ○ But little work has shown the effectiveness of these strategies in real classes

Spacing

**Cramming / “Massed”:** Study material all in one block

**Spacing:** Study material in several, shorter sessions that are spaced apart from each other

- Learners get multiple opportunities to review the material
- Learners tend to forget material between study sessions, leveraging the later refresher sessions
“Spacing out” learning improves long-term retention

- UNC students
- 80 synonym pairs of GRE terms

Re: **Self-testing**

Imagine reading a half-page passage of text containing information on a single scientific topic once for 5 minutes.

What percentage of factual information in the text do you think you could correctly recall after 7 days if you took one of the following study approaches:

1. No further studying
2. Repeated study (review): re-read text three more times
3. Retrieval Write down everything you remember. Read text again, and then write down everything you remember a second time.

Sketch your prediction!

We can often be poor judges of identifying the most successful strategies.

Rodriguez et al. (2018): Big Picture

Methodology: examine students’ study practices at the beginning and end of a sophomore-level bio class

1. Surveyed students at the beginning (wk 1) and end of the course (end of wk 10)

2. Course is taught in three sections: one was treated as the intervention group; two were used as controls
   - Brian taught the intervention group:
     - Wk 2: 10 min mini-lecture on spacing and self-testing
     - Brian reminded students each week thereafter to use spacing and self-testing


Brian Sato
1. Which of the following best describes your study patterns?
● I most often space out my study sessions over multiple days/weeks
● I most often do my studying right before the test

2. Select the top 3 study strategies you use most regularly. Please select ONLY 3.
● Test yourself with questions or practice problems
● Use flashcards
● Reread chapters, articles, notes, etc.
● Underlining or highlighting while reading
● Recopy your notes word-for-word
● Condensing/Summarizing your notes
● Recopy your notes from memory
● Make diagrams, charts, or pictures
● Study with friends
● Absorbing lots of information the night before the test
● Watch/listen to recorded lessons either by instructor or from outside source (Khan Academy, Youtube, etc.).
● Other

3. When studying, how do you generally decide what class to study for first? (open-ended)
## Class demographics

<table>
<thead>
<tr>
<th></th>
<th><strong>Year 1 Respondents</strong></th>
<th></th>
<th><strong>Year 2 Respondents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N = 544)</td>
<td></td>
<td>(N = 782)</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td></td>
<td><strong>Mean (SD) / Percentage</strong></td>
<td><strong>N</strong></td>
</tr>
<tr>
<td>Age</td>
<td>544</td>
<td>20.67 (1.94)</td>
<td>782</td>
</tr>
<tr>
<td>Female</td>
<td>338/544</td>
<td>62.13%</td>
<td>503/777</td>
</tr>
<tr>
<td>Male</td>
<td>205/543</td>
<td>37.75%</td>
<td>274/777</td>
</tr>
<tr>
<td>Asian</td>
<td>316/544</td>
<td>58.08%</td>
<td>402/782</td>
</tr>
<tr>
<td>White</td>
<td>105/544</td>
<td>19.30%</td>
<td>148/782</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>66/544</td>
<td>12.13%</td>
<td>145/782</td>
</tr>
<tr>
<td>International</td>
<td>32/544</td>
<td>5.88%</td>
<td>47/782</td>
</tr>
<tr>
<td>Other/Unknown</td>
<td>25/544</td>
<td>4.59%</td>
<td>40/782</td>
</tr>
<tr>
<td><strong>URM</strong></td>
<td>80/544</td>
<td>14.70%</td>
<td>169/782</td>
</tr>
<tr>
<td>First Generation</td>
<td>236/525</td>
<td>44.95%</td>
<td>372/759</td>
</tr>
<tr>
<td>Low Income</td>
<td>176/544</td>
<td>32.35%</td>
<td>272/781</td>
</tr>
<tr>
<td>1st Year</td>
<td>98/544</td>
<td>18.01%</td>
<td>168/782</td>
</tr>
<tr>
<td><strong>2nd Year</strong></td>
<td>388/544</td>
<td>71.32%</td>
<td>508/782</td>
</tr>
<tr>
<td>3rd Year</td>
<td>46/544</td>
<td>8.45%</td>
<td>92/782</td>
</tr>
<tr>
<td>4th Year</td>
<td>11/544</td>
<td>2.02%</td>
<td>10/782</td>
</tr>
<tr>
<td>5+ Years</td>
<td>1/544</td>
<td>0.00%</td>
<td>4/782</td>
</tr>
<tr>
<td>SAT Total Score</td>
<td>463</td>
<td>1808.51 (205.52)</td>
<td>658</td>
</tr>
<tr>
<td>High School GPA</td>
<td>433</td>
<td>4.06 (0.19)</td>
<td>600</td>
</tr>
<tr>
<td>Cumulative College GPA</td>
<td>544</td>
<td>3.28 (0.44)</td>
<td>782</td>
</tr>
<tr>
<td>Final Course Grade</td>
<td>544</td>
<td>7.99 (2.83)</td>
<td>782</td>
</tr>
</tbody>
</table>

Demographic data for students who completed both the pre- and post-surveys are listed above.

1 Underrepresented minorities (URMs) were categorized as Hispanic/Latino, African American, and Native American. Descriptive information for African American and Native American students are not reported individually due to small sample sizes and are categorized as Other/Unknown in this table. Final Course Grade ranged from 1 (F) to 13 (A+).

https://doi.org/10.1371/journal.pone.0200767.t001
## Overall pre-survey

<table>
<thead>
<tr>
<th>Study Patterns</th>
<th>Overall (N = 1,326)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing</td>
<td>56.71%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Strategies</th>
<th>Overall (N = 1,326)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Testing</td>
<td>65.00%</td>
</tr>
<tr>
<td>Re-Read Chapters</td>
<td>56.03%</td>
</tr>
<tr>
<td>Watch Video Lectures</td>
<td>30.31%</td>
</tr>
<tr>
<td>Condense Notes</td>
<td>31.29%</td>
</tr>
<tr>
<td>Make Diagrams</td>
<td>23.30%</td>
</tr>
<tr>
<td>Study with Friends</td>
<td>20.58%</td>
</tr>
<tr>
<td>Highlight/Underline Text</td>
<td>19.45%</td>
</tr>
<tr>
<td>Flashcards</td>
<td>19.15%</td>
</tr>
<tr>
<td>Recopy Notes</td>
<td>9.80%</td>
</tr>
<tr>
<td>Recopy Notes from Memory</td>
<td>6.18%</td>
</tr>
<tr>
<td>Other</td>
<td>1.35%</td>
</tr>
</tbody>
</table>
Pre-course survey patterns: URM vs non-URM

- % of Students

- URM (n = 249)
- non-URM (n = 1,077)

- Activities:
  - Space
  - Self-Test
  - Re-read chapters
  - Videos
  - Condense notes
  - Diagrams
  - Highlight/Underline
  - Flashcards
  - Study with friends
  - Recopy notes
  - Recopy notes from memory
  - Other

- Study methods:
  - URM
  - non-URM
Impact of intervention on self-reported use of spacing

Intervention groups increase use of spacing, Control groups decrease

Post-hoc analysis

<table>
<thead>
<tr>
<th>Pre</th>
<th>→</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>→</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>→</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>→</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>→</td>
<td>No</td>
</tr>
</tbody>
</table>
Impact of an intervention on students’ self-reported self-testing.

Intervention groups use self-testing significantly more than control groups.

Students dropped self-study w/o intervention:

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Active Learning in Intro Physics for Majors

Does changing students’ study strategies matter (re: course grade)?

<table>
<thead>
<tr>
<th>Study Patterns</th>
<th>Year 1 (n = 544)</th>
<th>Year 2 (n = 782)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used Strategy</td>
<td>Did not Use</td>
</tr>
<tr>
<td></td>
<td>Grade</td>
<td>Grade</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Spacing</td>
<td>55.33%</td>
<td>8.32 (2.63)</td>
</tr>
<tr>
<td>Study Strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Testing</td>
<td>50.55%</td>
<td>8.29 (2.70)</td>
</tr>
<tr>
<td>Re-Read Chapters</td>
<td>66.91%</td>
<td>7.79 (2.84)</td>
</tr>
<tr>
<td>Watch Video Lectures</td>
<td>28.30%</td>
<td>7.93 (2.85)</td>
</tr>
<tr>
<td>Condense Notes</td>
<td>38.41%</td>
<td>8.48 (2.67)</td>
</tr>
<tr>
<td>Make Diagrams</td>
<td>16.36%</td>
<td>8.51 (2.47)</td>
</tr>
<tr>
<td>Study with Friends</td>
<td>19.66%</td>
<td>8.17 (2.71)</td>
</tr>
<tr>
<td>Highlight/Underline Text</td>
<td>27.02%</td>
<td>7.74 (2.97)</td>
</tr>
<tr>
<td>Flashcards</td>
<td>12.13%</td>
<td>7.09 (2.83)</td>
</tr>
<tr>
<td>Recopy Notes</td>
<td>9.00%</td>
<td>7.55 (3.05)</td>
</tr>
<tr>
<td>Recopy Notes from Memory</td>
<td>2.88%</td>
<td>7.84 (3.02)</td>
</tr>
</tbody>
</table>

Final course grade was examined in the context of the particular study strategies students stated they used on the post-survey. For each study strategy, t-tests were used to compare grade differences between students who reported utilizing the study strategy compared to students who did not report using the strategy. Course grades were converted to numerical values for this analysis ranging from A+ (13) to F (1).

* $p < .05$
**$p < .01$
***$p < .001$

https://doi.org/10.1371/journal.pone.0200767.t005
URM and non-URM students who report self-testing earned the same course grades

**URM**
- Strategy: 8.01 +/- 2.5 (B-)
- Self-Testing: 8.75 +/- 2.7 (B-)

**non-URM**
- Strategy: 8.1 +/- 2.7 (B-)
- Self-Testing: 6.74 +/- 2.7 (C)
Prior research: survey of 177 college students

Open-ended question: List the strategies you use when studying

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Percent who list strategy</th>
<th>Percent who rank as #1 strategy</th>
<th>Mean rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rereading notes or textbook</td>
<td>83.6</td>
<td>54.8</td>
<td>1.5</td>
</tr>
<tr>
<td>2. Do practice problems</td>
<td>42.9</td>
<td>12.4</td>
<td>2.1</td>
</tr>
<tr>
<td>3. Flashcards</td>
<td>40.1</td>
<td>6.2</td>
<td>2.6</td>
</tr>
<tr>
<td>4. Rewrite notes</td>
<td>29.9</td>
<td>12.4</td>
<td>1.8</td>
</tr>
<tr>
<td>5. Study with a group of students</td>
<td>26.5</td>
<td>0.5</td>
<td>2.9</td>
</tr>
<tr>
<td>6. “Memorise”</td>
<td>18.6</td>
<td>5.6</td>
<td>2.0</td>
</tr>
<tr>
<td>7. Mnemonics (acronyms, rhymes, etc)</td>
<td>13.5</td>
<td>2.8</td>
<td>2.4</td>
</tr>
<tr>
<td>8. Make outlines or review sheets</td>
<td>12.9</td>
<td>3.9</td>
<td>2.1</td>
</tr>
<tr>
<td>9. Practise recall (self-testing)</td>
<td>10.7</td>
<td>1.1</td>
<td>2.5</td>
</tr>
<tr>
<td>10. Highlight (in notes or book)</td>
<td>6.2</td>
<td>1.6</td>
<td>2.3</td>
</tr>
<tr>
<td>11. Think of real life examples</td>
<td>4.5</td>
<td>0.5</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Percent of students listing different learning strategies, percent who ranked strategies as their #1 strategy, and mean rankings of strategies. Raw numbers of students are in parentheses.

Mean number of strategies listed was 2.9 ($SD=0.96$). Percentages of students indicating their #1 strategy do not add to 100% because some students merged multiple strategies when reporting their #1 strategy (e.g., indicating that rereading and rewriting notes were their #1 strategy).

Summary

• Used a “light-touch” study skills intervention (10 min mini lecture in wk 2 and weekly reminders) to encourage students to use spacing and self-testing when studying
• Students who received intervention were more likely to begin or continue using spacing and self-testing
• URM students who self-test earn similar grades to non-URM students who self-test
  • URM students who did not self test had significantly lower grades than non-URM students who did not self test
• Condensing notes and Making Diagrams are also effective study techniques!
### Table 4. Utility Assessment and Ratings of Generalizability for Each of the Learning Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Utility</th>
<th>Learners</th>
<th>Materials</th>
<th>Criterion tasks</th>
<th>Issues for implementation</th>
<th>Educational contexts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaborative interrogation</td>
<td>Moderate</td>
<td>P-I</td>
<td>P</td>
<td>I</td>
<td>P</td>
<td>I</td>
</tr>
<tr>
<td>Self-explanation</td>
<td>Moderate</td>
<td>P-I</td>
<td>P</td>
<td>P-I</td>
<td>Q</td>
<td>I</td>
</tr>
<tr>
<td>Summarization</td>
<td>Low</td>
<td>Q</td>
<td>P-I</td>
<td>Q</td>
<td>P-I</td>
<td>Q-I</td>
</tr>
<tr>
<td>Highlighting</td>
<td>Low</td>
<td>Q</td>
<td>Q</td>
<td>N</td>
<td>P</td>
<td>N</td>
</tr>
<tr>
<td>The keyword mnemonic</td>
<td>Low</td>
<td>Q</td>
<td>Q</td>
<td>Q-I</td>
<td>Q</td>
<td>Q-I</td>
</tr>
<tr>
<td>Imagery use for text learning</td>
<td>Low</td>
<td>Q</td>
<td>Q</td>
<td>Q-I</td>
<td>P</td>
<td>I</td>
</tr>
<tr>
<td>Rereading</td>
<td>Low</td>
<td>I</td>
<td>P</td>
<td>Q-I</td>
<td>P</td>
<td>I</td>
</tr>
<tr>
<td>Practice testing</td>
<td>High</td>
<td>P-I</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Distributed practice</td>
<td>High</td>
<td>P-I</td>
<td>P</td>
<td>P-I</td>
<td>P</td>
<td>P-I</td>
</tr>
<tr>
<td>Interleaved practice</td>
<td>Moderate</td>
<td>I</td>
<td>Q</td>
<td>P-I</td>
<td>P</td>
<td>P-I</td>
</tr>
</tbody>
</table>

**Note:** A positive (P) rating indicates that available evidence demonstrates efficacy of a learning technique with respect to a given variable or issue. A negative (N) rating indicates that a technique is largely ineffective for a given variable. A qualified (Q) rating indicates that the technique yielded positive effects under some conditions (or in some groups) but not others. An insufficient (I) rating indicates that there is insufficient evidence to support a definitive assessment for one or more factors for a given variable or issue.

Dunning Kruger Effect: The Illusion of Knowing

What is true of the students on the left?

“why incompetent people think they’re amazing…”

→ why inexpert students need help developing learning skills

Weekly Learning Paragraphs (an example of retrieval practice):

- Due every Friday at 10 am
- Respond to question posted on web

What is the one concept you learned this week that was the most challenging to master? Please also explain why it is challenging for you.
Example of Framework: Monthly Summary Sheets

Mary Pat Wenderoth
Think-Pair-Share

How can you prompt your students to use self-testing for your class?
Is it more effective to study a lot of problems of one type, or to vary your practice?

**Approach 1:**
Study material of all one type at a time

**Approach 2:**
Mix up the material you are studying

Which do you think is a more effective strategy?
Which strategy do you think students prefer?

How would you study to identify which artist painted this painting?

Which study strategy (1 or 2) do you think would help you better learn the artists’ styles?

Condition 1: “Interleaved”
- One painting by each of the six different artists

Condition 2: “Blocked”
- Six paintings by one of the artists

... \( x4 \) = 24 total paintings

Students’ Predictions

Judged effectiveness

Interleaved > Blocked
Blocked = Interleaved
Interleaved > Blocked

Results:

Each participant used both techniques

Proportion correct (%)

Interleaved
Blocked

Half the participants used one technique, half the other

Proportion correct (%)

Interleaved
Blocked

“Interleaving” (mixing up practice problems)

A Six paintings by one of the artists

B One painting by each of the six different artists

“Desirable Difficulties”

Test yourself (“self-testing” or “retrieval practice”)

Space your practice

Mix up your practice (interleaving)

Think about a class that you might teach: What are ways that you could implement some of these principles in your class?
Using Metacognition to Become an Expert Learner in [Chemistry]

(These slides are adapted from those that can be found under the “Resources” tab here: https://styluspublisher.presswarehouse.com/browse/book/9781620363164/Teach-Students-How-to-Learn#additional)
Great explanations are only one arm of effective teaching. The other arm involves teaching students how to learn material on their own, without help.

Teaching students how to learn entails opening their eyes to the learning process and introducing them to the myriad strategies they can use to increase their learning.

I now know that there are students who have an arsenal of strategies at their disposal and there are students who don’t.
Metacognition

The ability to:

- think about thinking
- be consciously aware of oneself as a problem solver
- monitor and control one’s mental processing (e.g. “Am I understanding this material?”)
- accurately judge one’s level of learning
Turning Yourself into an Efficient, Expert Learner

- Do “think aloud” exercises
- Constantly ask yourself “Why,” “How,” and “What if” questions
- Always test your understanding by verbalizing or writing about concepts; practice retrieval of information
- Move your activities higher on the **Bloom’s taxonomy** scale by comparing and contrasting, thinking of analogies, thinking of new pathways, etc.
This pyramid depicts the different levels of thinking we use when learning. Notice how each level builds on the foundation that precedes it. It is required that we learn the lower levels before we can effectively use the skills above.

- **Knowledge**: Memorizing verbatim information. Being able to remember, but not necessarily fully understanding the material.

- **Comprehension**: Identifying components; determining arrangement, logic, and semantics.

- **Application**: Using information to solve problems; transferring abstract or theoretical ideas to practical situations. Identifying connections and relationships and how they apply.

- **Analysis**: Making decisions and supporting views; requires understanding of values.

- **Synthesis**: Combining information to form a unique product; requires creativity and originality.

- **Evaluation**: Restating in your own words; paraphrasing, summarizing, translating.
At what level of Bloom’s did you have to operate to make A’s or B’s in high school?

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation
At what level of Bloom’s do you think you’ll need to be to make an A in Chem 1201?

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation
How do you move yourself higher on Bloom’s Taxonomy?

Use the Study Cycle!
The Study Cycle

**Preview**
- **Preview before class** – Skim the chapter, note headings and boldface words, review summaries and chapter objectives, and come up with questions you’d like the lecture to answer for you.

**Attend**
- **Attend class** – GO TO CLASS! Answer and ask questions and take meaningful notes.

**Review**
- **Review after class** – As soon after class as possible, read notes, fill in gaps and note any questions.

**Study**
- **Study** – Repetition is the key. Ask questions such as “why”, “how”, and “what if”.
  - **Intense Study Sessions*** – 3-5 short study sessions per day
  - **Weekend Review** – Read notes and material from the week to make connections

**Assess**
- **Assess your Learning** – Periodically perform reality checks
  - Am I using study methods that are effective?
  - Do I understand the material enough to teach it to others?

*Intense Study Sessions

1. **Set a Goal** (1-2 min)
   - Decide what you want to accomplish in your study session.

2. **Study with Focus** (30-50 min)
   - **Interact with material** - organize, concept map, summarize, process, re-read, fill-in notes, reflect, etc.

3. **Reward Yourself** (10-15 min)
   - **Take a break** – call a friend, play a short game, get a snack

4. **Review** (5 min)
   - Go over what you just studied
Effective Metacognitive Strategies

- Always solve problems without looking at an example or the solution
- Memorize everything you’re told to memorize (e.g. polyatomic ions)
- Always ask why, how, and what if questions
- Test understanding by giving “mini lectures” on concepts
- Spend time on chemistry every day
- Use the Study Cycle with Intense Study Sessions
- Attend SI sessions on a regular basis
- Aim for 100% mastery, not 90%!
Concept maps facilitate development of higher order thinking skills
Compare and Contrast

Concept #1

How are they similar?

How are they different?

Concept #2
Which One of the Next Two Slides More Accurately Describes YOUR Actions Before Test 1?
Top 5 Reasons Folks Did Not Do Well on Test 1 in Chemistry 1201 in Fall 2009:

1. Didn’t spend enough time on the material
2. Started the homework too late
3. Didn’t memorize the information I needed to
4. Did not use the book
5. Assumed I understood information that I had read and re-read, but had not applied.
Top 5 Reasons Folks Made an A on Test 1:

1. Did preview-review for every class
2. Did a little of the homework at a time
3. Used the book and did the suggested problems
4. Made flashcards of the information to be memorized
5. Practiced explaining the information to others
Get the Most Out of Homework

1. Start the problems early--the day they are assigned
2. Do not flip back to see example problems; work them yourself!
3. Don’t give up too soon (<15 min.)
4. Don’t spend too much time (>30 min.)
Get the Most from Tutorial Centers, Office Hours, and Study Groups

- Try to understand the concept or work the problem by yourself first
- Come prepared to ask questions
- Explain the material to the tutor or instructor
What strategy will you use for the next three weeks?
If you don’t try it in within the next 48 hours...

... you probably never will.
Cook *et al.* (2013): General chemistry

Mcguire led a 50 min lecture with 3 goals:

1. Explain to students why the skills that they found effective in high school no longer work at the university;
2. offer students a smorgasbord of metacognitive learning tools to replace or supplement those used in high school; and
3. secure from the students a commitment (via a short writing exercise) to use those tools in the weeks following the presentation.

### For 2011:
- Attendees Exam 1: 74
- Non-attendees Exam 1: 68

→ Gap existed, but grew


![Table 2. Final Average Course Grades in the General Chemistry I Course in the Fall 2010 and 2011](image)
Zhao et al. (2014): Gen chemistry

Gave an intervention upon handing back exam 1

- “Give the top 3 reasons you believe you did well or poorly on this exam."
- First slide of intervention: “The Goal: Get an A!”
- Objectives:
  - Analyze your current learning strategies
  - Distinguish between meaningful learning and rote memorization
  - Introduce concrete and effective strategies
Fall 2011 was the intervention year

Fall 2009 and 2010 are negative controls
Would you be interested in developing materials to help your student succeed?

Here are some examples of what we could do here...
1. Test yourself with questions or practice problems (selftest)
2. Reread chapters, articles, notes, etc.
3. Watch/listen to recorded lessons either by instructor or from outside source
4. Condensing/summarizing your notes
5. Study with friends
6. Absorb lots of information the night before the test
7. Make diagrams, charts or pictures (visualize)
8. Use flashcards
9. Underlining or highlighting while reading
10. Recopy your notes word-for-word
11. Recopy your notes from memory
Effective Strategies

Self-Test:
Test yourself with questions or practice problems
(Rodriguez, 2018)

Condense:
Condensing/summarizing your notes
(Rodriguez, 2018)

Visualize:
Make diagrams, charts or pictures
(Rodriguez 2018)

Memory:
Recopy your notes from memory
(Karpicke & Blunt, 2011)
Ineffective Strategies

Flashcards:
Use flashcards
(Rodriguez, 2018)

Reread:
Reread chapters, articles, notes etc.
(Rodriguez, 2018)
Student Use vs. Perception of Learning Strategies (pre-test Fall 2019)

From analysis to action

- Facilitate
- Reinforce
- Inform
- Reframe

Understanding of strategy

Use of strategy

- Low
- High

% Think is useful

% Use regularly
Possible Interventions

1. **Reinforce**: How can you make practice tests work best for you? (Demonstrate how much more effective self-testing is than rereading, and how to self-test effectively.)

2. **Reframe & Facilitate**: While re-reading your notes, you should condense material and make sense of it by creating diagrams, charts, and pictures (Nudge students towards learning practices with higher cognitive demand)

3. **Inform**: Flashcards can be an effective study aid if you are using them in a way that promotes interleaving or retrieval practices. (Define, give examples, and evidence for effectiveness)
Develop in-class activities

1. How to study using a practice exam

Jamie and Alex are two students studying for an exam, using the blank practice exam and answer key provided by the course. Both Jamie and Alex give themselves only 90 minutes to complete the blank practice exam, as recommended by their instructors and TFS. However, whereas Jamie looks at the answer key for confirmation after each question while taking the practice exam, Alex does all the questions on the practice exam in 90 minutes without looking at the answer key until the 90 minutes are over (as shown below).

Do you think Jamie or Alex is studying more effectively for their exam? Briefly explain your reasoning.
2. Self-testing vs rereading in-class activity

A. In the first experiment, students were divided into two groups:
   - Group 1 got to read the material twice (“Study, Study”)
   - Group 2 got to read the material once and then tested themselves on it (“Study, Test”)

   How did the two groups differ in the retention of the material two days later? A week later?

B. In a follow up experiment, they compared students who:
   - Read material, and then re-read it 3 more times (“SSSS” condition)
   - Read the material, then re-read it 2 more times, then tested themselves (“SSST” condition)
   - Read the material once, then tested themselves over and over and over again (“STTT”)

   Which student group learned the material most deeply?
   How will this impact how you study for your next exam?
2. Self-testing vs rereading TA-led activity


Subjects 80 undergraduates.

Learning Material A prose passage (275 words in length) on a single scientific topic ("Sea Otters") with 30 idea units/concepts.

Learning process S or T represents 7 min of time. C is 2 min of a distractor task.

Group 1: S Study the passage for the first and only time

Group 2: S T S T S T C
Study the passage for the first time, then reread three more times.

Group 3: S T S T S T C
Study the passage for the first time, take a test, then reread, and take another test.

The tests are free-recall tests (write down on a blank sheet as much of the material from the passage as they could remember).

After 1 week, students are tested with questions on the passage, some of which assess conceptual knowledge stated directly in the text and others require students to connect multiple concepts from the text. Which student group do you think retained the material better after 1 week?

| Correct % | $S$ | $S$-$S$-$S$ | $S$-$T$-$S$-$T$
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<td>prediction</td>
<td>~68</td>
<td>~80</td>
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| 14 Verbatim Questions - assess conceptual knowledge stated directly in the text | 28 ± 2 | 46 ± 3 | 68 ± 2 |
| 2 Inference questions - require students to connect multiple concepts from the text | 28 ± 5 | 57 ± 5 | 68 ± 2 |

T&F note: We'll do a warm-up activity and discuss best learning practices we recommend in PS11.

1. Why do we do this activity? To be transparent about the learning practices we recommend. This is based on educational research, and also confirmed by past PS11 students' experience.

2. Let's first look at an educational experiment reported in the journal of Science in 2011.

- do not look at the back yet
- read and answer the question at the bottom, and we will have anonymous vote after this.
- have them close their eyes and vote
- reveal the result at the back, discuss in large group why Group 3 retain material better.

Take-away: They get to identify the areas that they do not know, and the follow-up study is more targeted, i.e. check to know what you do not know, and get help to learn those.

3. Pair and share: how to apply this to PS11? (Give the 2nd handout out, ask them to wait & look at it together late).

Student handout: front side


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Student interviews
Narratives about how they study, and how they learned how to study
Student interviews

Narratives about how they study, and how they learned how to study, for example:
Summary

- Effective study strategies include
  - Self test (“retrieval practice”)
  - Condense
  - Visualize
  - Memory
  - Spacing and interleaving
  - Promoting “metacognitive” awareness of student’s own strengths and areas for improvement

- Less effective study strategies (potentially even negative)
  - Rereading/rewatching
  - Flashcards (can be improved by emphasizing interleaving)

- Study cycle
  - Emphasizes targeted, spaced learning
  - Motivated by early opportunity to struggle in class and by teaching Bloom’s taxonomy

- Share with your students how you want them to study
  - Design in-class or homework assignments or study guides that teach how to study (not just what to study)