Friday 7 June.
12-1pm: How to study and learn effectively. Target audience: undergraduate and coursework Masters students.

What is the most effective way to study and learn? Studies show that students are not good judges of which approaches result in durable memory because they have a faulty model of how people learn and remember. Moreover, most students have not been exposed to effective study methods. Learning strategies will be presented on how to prepare for exams without devoting more time to studying.

How to Study and Learn Effectively

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Discuss some aspects of learning strategies
Goal is lifelong learning

How to make today's workshop more effective?
1. Sit in the front of the class

2. Actively participate

3. Put away cell phone

4. Put away computer unless tablet that allows handwriting
5. Summarize *after* the workshop

6. Read one of the books after the workshop

7. Read the online info after the workshop

8. Commit to implementing one or more strategies

   Continuously improve
Which decreases your IQ more?

A  

B  

C  

Multitasking does **not** work

Study 1,100 workers at a British company:

Multitasking with electronic media decrease IQ more than smoking pot or losing a night’s sleep.
List which are the most effective study approaches

- Reread textbook
- **Underline** and **highlight textbook**
- Review notes before exam
- Reread solutions to HW problems before exam
- Concentrated study on one topic
- Study in the same location
- Study several hours non-stop
- Being persistent: continue trying to solve problem when stuck
  i.e., trying longer than 30 minutes

Conclusions?
You're not a good judge of what results in the best retention!!

You need to change how you study

How to change?
You may not have received much information on how to study

**Why not reread?**

Time consuming

Does not test recall *(recall is different from recognizing)*

Does not spend time on things you forgot

Does not result in durable memory

Self-deception- growing familiarity starts to feel like mastery

*Used because of a faulty model of how we learn and remember*
Going over a highlighted text: passive, can cause *fluency illusion*.

List of paired items to test learning (chair-nine, horse-mouse, forest- seven)

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>read list</td>
<td>6 times</td>
<td>6 times</td>
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</table>
Which group learned more?

Learning **same for both groups** even though the first group saw the nouns 6 more times.

Mere repetition did not enhance learning.

*Which results in better learning? Trying to solve a problem*
A. before being taught the solution
B. after reading the textbook
C. after watching the instructor solve a problem
D. by looking at an example problem in the textbook

Which approach do you use?

Any time you look up an answer or have somebody show you something that you could generate instead, you rob yourself of a powerful learning opportunity.
People remember things better, longer, if they are given very challenging tests on the material, tests at which they are bound to fail.

Practice testing (active retrieval) had the most evidence supporting its benefits for learning across context and over time.
Practice retrieving improves learning for facts, complex concepts, problem-solving techniques, and motor skills.
Retrieving a memory makes it stronger.

The harder your brain works to dig out the memory, the greater the increase in learning

Active retrieval tells what you know and don’t know

Not all of our intellectual abilities are hardwired. When learning is effortful, it changes the brain, making new connections increasing intellectual ability.
**Testing increases retention** (Brown et al. (2014) p 34-35)

All material covered in classroom, homework, etc.

Divide material to be tested into three groups

Quizzes not graded

In-class quizzes and review statements interspersed

<table>
<thead>
<tr>
<th></th>
<th>1/3(^{rd})</th>
<th>1/3(^{rd})</th>
<th>1/3(^{rd})</th>
</tr>
</thead>
<tbody>
<tr>
<td>in addition to normal</td>
<td>quiz at start of class</td>
<td>review statements in class</td>
<td>nothing additional</td>
</tr>
<tr>
<td>instruction</td>
<td>quiz at end of class</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>review quiz 1 day before exam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>end of semester exam</td>
<td>92%</td>
<td>79%</td>
<td>79%</td>
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</table>

Note: performance on material that reviewed same as on material not reviewed; i.e., rereading did not help
Which approach is closest to what you use for studying a particular subject?

<table>
<thead>
<tr>
<th></th>
<th>Mon</th>
<th>Wed</th>
<th>Fri</th>
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<tbody>
<tr>
<td>A.</td>
<td>30 min</td>
<td>30 min</td>
<td>30 min</td>
</tr>
<tr>
<td>B.</td>
<td>------</td>
<td>90 min</td>
<td>------</td>
</tr>
<tr>
<td>C.</td>
<td>45 min</td>
<td>45 min</td>
<td>------</td>
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</table>

Which study approach is more effective for learning a particular subject?

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<td>------</td>
</tr>
<tr>
<td>C.</td>
<td>45 min</td>
<td>45 min</td>
<td>------</td>
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</table>
Conclusion?

Spaced practice—spread same learning over several days.

Learn pairs of syllables and adjective (lum-happy)

test: 1 day later

Pairs recalled

1-day delay

massed learning
8 times: same day

distributed learning
2 times per day: 4 days
Repeated *practice testing* works best when spaced.
How can you improve learning that does not involve studying?

Exercise

Get enough sleep

- improves memory and learning ability
- enhances growth of hippocampus cells
- reduces stress
- improves ability to focus
- exercise causes platelets in the blood release factors that boost the growth of neural precursor cells in the hippocampus

**Sleep**

- has an important role in memory formation
- if you don’t sleep, you’ll remember a lot less
- sleep deprivation can worsen performance in a declarative memory test by as much as 20-50%

Students given a series of math problems with a method to solve them.

12 hours later, given more problems

<table>
<thead>
<tr>
<th>12-hour delay</th>
<th>Percent who discovered shortcut</th>
</tr>
</thead>
<tbody>
<tr>
<td>awake</td>
<td>20%</td>
</tr>
<tr>
<td>sleep 8 hours</td>
<td>60%</td>
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</tbody>
</table>
Interleaved practice
Percentage correct answers on sets of problems

Test: 1 week later
Find volumes of different geometric solids

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>practice problems</td>
<td><img src="image1" alt="Shapes" /></td>
<td><img src="image2" alt="Shapes" /></td>
</tr>
<tr>
<td>% correct during practice</td>
<td>89%</td>
<td>60%</td>
</tr>
<tr>
<td>% correct on test 1 week later</td>
<td>20%</td>
<td>63%</td>
</tr>
</tbody>
</table>
Learning from interleaved practice feels slower (can be confusing)
Much more effective in long term

You're not a good judge of what results in the best retention!!

Percent of logical reasoning problems answered correctly
Constantly ask yourself “why?” and “what if?” questions

Participants who talked out loud to themselves while solving abstract logic puzzles performed 3 times better than those who worked in silence.

**Metacognition** is the ability to
think about thinking
be consciously aware of oneself as a problem solver
to monitor and control one’s mental processing

Study in various locations: you need to recall in various locations.
Simply alternating the room where you study improves retention.
Vary conditions, background, type music, etc.
Memorizing 40 words (same study time):

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<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>study twice</td>
<td>1 room</td>
<td>2 rooms</td>
</tr>
<tr>
<td>words remembered</td>
<td>16</td>
<td>24</td>
</tr>
</tbody>
</table>

The brain makes subtle associations between what it is studying and the background sensations it has at the time.
Learning strategy (interruption to initiate percolation)
Start work on large projects as soon as possible
Stop when stuck - this activates the project and initiates percolation
  sleep, exercise, work on something else

Two modes of thinking:
Focused: Concentrating on things that are usually familiar.
Diffused: A relaxed mode of thinking "your thoughts are free to wander".
The best way to prepare for a test is to ______________________________

Self-explanation
Explain how new info is related to known info
Explain steps during problem solving.

All learning is creating a relationship between known and unknown.
Increase retention by memorizing more
How to Study/How to Learn

Screeencasts

- How to Study, Part 1 - discusses practice testing
- How to Study, Part 2 - discusses distributed practice and interleaved practice
- How to Study, Part 3 - discusses additional approaches to studying to improve retention, an
- How to Study using Screeencasts
- Testing Effect - the testing effect is the finding that long-term retention and memory is impro
- Spaced Repetition - spaced repetition is a learning technique where you review material am
- Interleaved Learning
- Memory Rehearsal: Factors in Learning Chapter
- Fixed Mindset vs. Growth Mindset
- 13 Study Tips - some tips that are based on widely accepted research by neuroscientists an

Handout

- How to Study/How to Learn

Recommended reading

How to Study screencasts on [www.LearnChemE.com](http://www.learncheme.com/student-resources/how-to-study-resources) and YouTube