Cognitive Principles of Learning and Memory

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Goals of this Workshop

- To help students learn more effectively in class
- To help students study what they have learned more effectively

Why Learning Can Be Difficult

- PROBLEM:
  - “When I'm listening in class, it all makes sense (so I don’t need to write anything down)”
  - Why this is a problem:
    - Long-term memory is good at retaining the gist, not the details
- SOLUTION:
  - Encourage students to take good, comprehensive notes, which become the basis for their subsequent studying

How to Encourage Good Notetaking

- Get students to actively participate
  - Ask questions, do demos, have them read before class
  - Get them to critically analyze the information you are covering
- Notetaking strategies
  - Have them take notes in their own words, rather than just regurgitating yours from short-term memory
  - Incorporate notes from the book into lecture notes

Why Learning Can Be Difficult

- PROBLEM:
  - “There is so much information that I can’t write everything down.”
  - Why this is a problem:
    - Notes end up being incomplete
    - Aren't processing the meaning of the lecture
- SOLUTION:
  - Allow students to record the lecture
  - Provide PowerPoint outlines of lecture
  - Encourage students to swap notes with someone

Why Studying Can Be Difficult

- “There is too much material, so I can’t possibly study everything.”
- “When I’m studying, I feel like I know the material.”
- “I studied SO MUCH, but I still didn’t do well on the exam.”
How to Study More Effectively

- What to do:
  - Elaborate
  - Test
  - Organize
  - Take breaks
  - Use variable encoding

Get Students to Elaborate

- Elaborate
  - Associate what they are learning with other things they have stored in memory
    - Levels of processing theory
      - The depth at which we process information during encoding determines how well we recall it (Craik & Lockhart, 1972)

Recall all the words that you saw earlier (the ones paired with the different questions)

Levels of Processing Theory

- Craik & Tulving (1975)
  - Presented nouns one at a time, and one of three types of questions:
    - Shallow processing: Is the word in capital letters?
    - Less shallow processing: Does the word rhyme with _____?
    - Deep processing: Does the word fit in the sentence…?

In our demo:
- Shallow (features):
  - book, snow, flower, tree, fox
- Less shallow (sounds)
  - safe, weight, color, hall, day
- Deep (meaning)
  - duck, house, student, robin, textbook

More likely to recall words judged on meaning
Least likely to recall words judged on appearance
Deep Processing

- In what other ways can people process information deeply?
  - Self-reference
  - Imagery
  - Generation

Self-Reference Effect

- Rogers, Kuiper, & Kirker (1977)
  - Encoding with respect to oneself increases memory

Generation Effect

- Slamecka & Graf (1978)
  - Read pairs of related words: sea-ocean
    - Involves reading
  - Fill in the blank with a word related to the first word: sea-oc_____
    - Involves generating
  - Also manipulated depth of processing
    - Deep: words related in meaning
    - Shallow: words related in sound (rhymes), e.g., save-cave
  - Then gave a recognition test:
    - diamond  ocean  light

Imagery

- Create images that link things, and visualize them interacting with each other

Real-World Examples of Generation

- Talk out loud when studying
- Explain the material to someone else
Testing Effect

Roediger & Karpicke (2006, Expt 1)

- Read prose passage
- Restudied passage OR took recall test
- Took recall test

Took recall test immediately, 5 min, 2 days, or 1 week later.

Roediger & Karpicke (2006)

- Immediate testing resulted in better long-term retention than restudying.

Get Students to Test Themselves

- Self-test by asking themselves questions
- “Test Yourself” & “Think About It” questions
- Sample test questions available on “Study Help from Publisher” link in e-learning
- Create their own questions
- Complement individual studying with a study group
- Make sure to generate answers!

Get Students to Organize

- Organize
  - Go through your lecture notes and organize them that same day
    - “Should I rewrite my notes?”
      - If so, use different words this time
  - Make your own study guides for exams

Roediger & Karpicke (2006)

- Repeated testing is better for long-term retention than repeated study, even with reading the passage much less!

Graph:

- Proportion of idea units recalled vs. retention interval (5 minutes vs. 1 week).
  - Immediate testing (SSSS) vs. repeated study (STTT) comparison.
Get Students to Take Breaks

- Take breaks
  - Study in a number of shorter study sessions rather than trying to learn everything at once
    - Spacing effect

Spacing Effect

- Smith & Rothkopf (1984)
  - Gave an 8-hour statistics course, 4 lessons presented in one day (massed instruction) or four days (spaced instruction)

<table>
<thead>
<tr>
<th>Massed instruction</th>
<th>DAY 1</th>
<th>DAY 2</th>
<th>DAY 3</th>
<th>DAY 4</th>
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</thead>
<tbody>
<tr>
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<tr>
<th>Spaced instruction</th>
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<th>Lesson 2</th>
<th>Lesson 3</th>
<th>Lesson 4</th>
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<table>
<thead>
<tr>
<th>Study</th>
<th>Study</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room A</td>
<td>Room A</td>
<td>Test C (Recall = 40%)</td>
</tr>
<tr>
<td>Room A</td>
<td>Room B</td>
<td>Test C (Recall = 61%)</td>
</tr>
</tbody>
</table>

- Studying in two different rooms led to greater recall than studying in one room

Variable Encoding

- Smith, Glenberg, & Bjork (1978)
  - Studied lists twice, either in same or different contexts:

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- Studying in two different contexts led to greater recall than studying in one context

How to Study More Effectively

- What students should NOT do:
  - Simply memorize their notes
  - Create illusions of learning
  - Rely on metacognition

What NOT to Do

- Do not memorize your notes
  - Instead, apply what you have learned
  - Come up your own examples
What NOT to Do

Do not create “illusions of learning”

- Rereading
  - Leads to greater fluency, not better memory

- Highlighting
  - Seems elaborative, but often becomes automatic

Do not rely on metacognitive indicators

- Our knowledge about our own memory is not always accurate
- Encourage students to review their exams

Abrams metacognition demo

What measures from BEFORE the exam correlate with actual exam score?

<table>
<thead>
<tr>
<th></th>
<th>Above</th>
<th>Below</th>
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</thead>
<tbody>
<tr>
<td>I felt prepared:</td>
<td>$r = .21$</td>
<td>$r = .22$</td>
</tr>
<tr>
<td>I studied:</td>
<td>$r = .26$</td>
<td>$r = .03$</td>
</tr>
<tr>
<td>Hours studied:</td>
<td>$r = .34^*$</td>
<td>$r = -.06$</td>
</tr>
<tr>
<td>My score will be:</td>
<td>$r = .25$</td>
<td>$r = .08$</td>
</tr>
</tbody>
</table>

Please circle a rating for each statement:

- I felt prepared to take this exam.

  Not at all | A little | Average | Prepared | Extremely prepared
  1 2 3 4 5 6 7 8 9

- I studied for this exam. (also, put # hours here ___)

  Not at all | A little | Average | More than usual | A lot
  1 2 3 4 5 6 7 8 9

- I think that my score on this exam will be:

  Poor | Fair | Average | Good | Excellent
  1 2 3 4 5 6 7 8 9