COGNITIVE SCIENCE: IMPROVE YOUR TEACHING, LEARNING, AND JUMP SHOT

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Cognitive Science

• Learning: Act of acquiring new information or skills
  – Modifying/reinforcing prior knowledge
  – Available for future use

• Cognitive Science: The study of learning, and development of practices to optimize learning
  – Psychology
  – Neuroscience
  – Education
Make it Stick, 2014
Peter Brown
Henry Roediger
Mark McDaniel
Which is the Real Penny?
### Which is the Real Penny

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<th>Letter</th>
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The real penny
Study Smarter
Study skills: Practice tests

- Students read a passage and are tested on how much they remember 5 minutes later
- Three groups of students
  A. Read four times, then real test
  B. Read three times, practice test, real test
  C. Read once, three practice tests, real test
- No feedback after practice tests
Reading vs Testing

Which strategy was most successful at 5 minutes?

A. Read four times, then real test 33%
B. Read three times, practice test, real test 33%
C. Read once, three practice tests, real test 33%
Reading vs Testing

Roediger & Karpicke, 2006
Reading vs Testing

Which strategy was most successful at one week?

A. Read four times, then real test  33%
B. Read three times, practice test, real test  33%
C. Read once, three practice tests, real test  33%
Reading vs Testing

Roediger & Karpicke, 2006
Retrieval strengthens memory.

Once you try to remember something, it is easier to bring back the next time.

Repeated recall strengthens and multiplies the neural connections.

Delays forgetting.

To cement knowledge, test yourself.

While reading: ask yourself to rephrase the key points.

Guess what the points will be before you start, and then check yourself.

Make up questions to use after you read.
Surgical Skills

- Microsurgical Simulation for Residents
  - Typical session: Half day instruction and practice
  - Spaced Sessions: One session per week over a month
  - Test: Rat simulation
- Immediate Test: Both groups performed similarly
Surgical Skills

- Post Training Test - one month after last session
  - Spaced Group outperformed Typical group
- Time to complete surgery, hand movements, successful reattachment
- 16% of Usual group could not complete the surgery
Spacing

• Taking breaks from a topic solidifies knowledge
  – Consolidation to long term memory takes at least hours or days

• Longer spacing results in longer term retention
  – If a little forgetting has happened, all the better
Paul Cezanne
Henri Matisse
Paul Gauguin
Paul Gauguin
Henri Matisse
Paul Cezanne
Paul Cézanne
Henri Matisse
Which group did better?

A. Studied paintings grouped by artist
B. Studied paintings in random order
Grouped vs Interleaved studying

- Students who studied the artists and paintings in random order (INTERLEAVED) performed better
  - 80% better
- Crossover design
  - everyone studied both ways
- 80% of students *THOUGHT* they did better with massed practice
  - Even when they knew the test results

Kornell and Bjork 2008
Motor training: Baseball

- Six weeks of batting practice
  - Standard practice: 15 fastballs, 15 curve balls, 15 changeups
  - Varied Practice: 45 pitches in random order
- Standard practice group felt they were improving
- Varied Practice group was frustrated
- Varied practice group performed better
Interleaving and Spacing

- Take a break, and come back later
  - Add review questions on old material
- In the space, study something different
  - We learn from the differences
- Three admissions for chest pain on a single night
  - Discuss how they are different
  - Recall the admission from two calls ago
Another question...
Beanbag Toss

- Practiced 12 weeks
  - A. One Group: always 3 feet away 50%
  - B. Second Group: Alternated 2 feet and 4 feet 50%
- The test was on a 3 Foot Bucket

Who Did Better?
Beanbag Toss

• Group who had varied practice performed better
  – No matter the age
  – No matter the baseline ability
• Varied practice increases flexibility
  – Adaptable to new conditions
Myth of Massed Practice

• Testing, Spacing, and Interleaving FEELS inefficient
• Rapid gains make us THINK we are learning
  – Rapid gain = rapid forgetting
• Massed Practice isn’t true to life
I promised you a jump shot

- Shoot jump shots (Testing effect)
- Take a break (Spacing)
  - Defense skills
  - Ball control
- Mix it up (Interleaving)
  - Practice layups
  - All over the court
  - With defenders
- Listen to your coach
Improve your teaching
Testing Effect

- Teaching through questions is powerful
- Testing for learning should be:
  - Low stress
  - Non judgmental
  - Regular
Teaching through questions

- Open ended
- Designed to explore the thought process
- Can be followed up with a “why” question
Spacing Your Teaching

- Encourage reading after you have discussed a topic
- Repeat questions or learning points over time

"Repetition is the mother of all learning" - Old Russian Proverb
Interleaving Your Teaching
Desirable Difficulties

• Learning for understanding
  – Requires active processing
  – Requires deep processing

• Use questions to make the learner talk
  – Have learner apply knowledge via a case
“The problem with medical students is that they try to learn too much; the problem with medical educators is that they try to teach too much”

Teach to Promote

- Retrieval enhancing strategies
  - Show or ask applicability
  - Teach Advanced Organizers
Advanced Organizers

- Mental constructs useful to organize knowledge
  - Acronyms, mnemonics, algorithms and diagrams
- **AKI**: prerenal, intrinsic, postrenal
- **Anemia**: factory production of RBCs
- Helps retrieval later

Teaching on the fly: Cognitive Science Style

Microskills of clinical Teaching

1. Obtain a commitment
2. Probe for supporting evidence
3. Teach general rules
4. Reinforce what was right
5. Correct mistakes

Chalk Talk: Cognitive science style

- Start with a case
- Show applicability
- Teach an advanced organizer
- Use questions throughout the whole talk
  - My approach to the problem
- End with learners applying knowledge to another case
- Refer back to chalk talk in subsequent teaching
Takeaways

• Retrieval is critical to studying
  – Know what you don’t know

• Spacing and Interleaving allow for memory consolidation

• Practice like you play
  – Mix it Up

• Talk less, ask more
  • Promote metacognition
  – Teach and Model study skills
References

- Roediger & Karpicke. The Power of Testing Memory: Basic Research and Implications for Educational Practice. 2006, Psychological Science, volume 17, issue 3, p 253
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- Bloom B. The 2 sigma problem: the search for methods of group instruction as effective as one to one tutoring. Educational Res (1984) 13, 4-16
- Wood WB and Tanner KD. The role of lecturer as tutor: Doing what effective tutors do in a Large lecture class.. CBE Life Sciences Ed. 2012. 11, 3-9
Application of Knowledge

http://serc.carleton.edu/introgeo/enviroprojects/what.html
Set The Stage
1. Summarize the patient’s circumstances and revise the student’s question.
2. Reinforce importance of the question.
3. Foretell the answer to the question.
4. Explore the student’s understanding of the topic.

Deliver Chalk-Talk
5. Deliver message effectively.
   a. General→Specific
   b. Simple.
   c. Engaging.
   d. Organized and memorable.

Recruit The Student
6. Ask the student to summarize the patient’s circumstances.
7. Ask the student to repeat the question at the close of the talk.
8. Encourage the student to answer the question based on what was just learned.

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Zimmerman, Go, et al.
ACGME 2012