

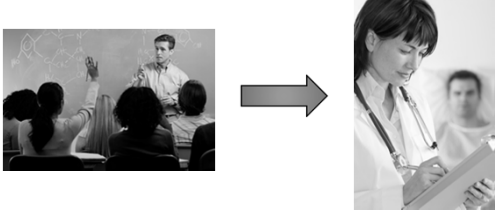
## Redefining the role of testing in education!

Douglas P. Larsen, M.D., M.Ed.  
 Assistant Professor of Neurology & Pediatrics  
 Department of Neurology  
 Washington University School of Medicine


## Disclosures

- McDonnell Center for Systems Neurosciences at Washington University
- American Academy of Neurology Education Research Grants

## Our typical concept of health professions education




## Where to start?



- Begin with the end
- What is your real goal?
  - Change from what to I want them to learn to how do I want them to use it?
- Think about
  - Learning Outcome (What form of knowledge does this really entail?)
  - Prerequisites (Do my learners have the foundation to do what I want them to do?)
  - Time (When do I want them to use this?)

## Is this enough?



Practice!

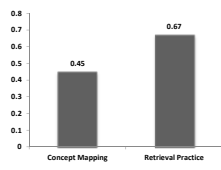
## Retrieval practice: A tool from cognitive psychology

- Subjects learned 40 word pairs of Swahili and English words until initial learning was complete.
- Subjects randomized to four conditions.
- Retention measured one week later.

Condition	Retention at one week
Repeated study and testing	80%
Repeated testing alone	80%
Repeated study alone	36%
No further exposure	33%

### What if you just study better?

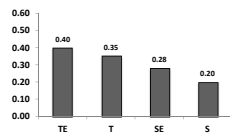
- Subjects studied both enumerated and sequential science texts.
- Randomized to learn materials either through concept mapping or repeated short-answer testing.
- Final test one week later—using both verbatim and inferential questions.



Karpicke & Blunt, 2011

### What about with medical students?

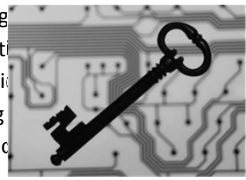
- Students learned four clinical topics (26-30 items per topic).
- Randomized to four different learning activities—one for each topic:
  - testing with self-explanations (TE)
  - repeated testing (T)
  - studying with self-explanations (SE)
  - Studying (S)
- Final essay style application test 6 months after initial learning.



Larsen et al., 2013


### Retrieval—the key ingredient

- Alignment with learning
- Productive
- Repetition
- Spacing
- Feedback



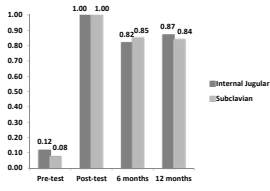
### Alignment

- Testing and retrieval practice should include the target type of application.
- To learn concepts (or classification groupings), students should practice that particular skill.
- To learn psychomotor skills, students should practice those particular actions.
- Think broadly about retrieval—don't just limit it to written tests!



### Central line insertion

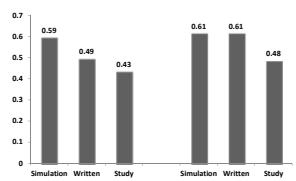
- Internal medicine residents learned internal jugular and subclavian line placement through repeated practice and mastery learning with simulation.
- Competence > 80% performance on clinical checklist
- 87% and 84% of participants maintained competence after 12 months!



Barsuk et al., 2010

### Clinic patients


- Students learned three clinical neurology topics.
- Students were randomized to one of three activities for each topic: repeated testing with standardized patients, repeated written testing, and repeated studying.
- Six months after initial learning students took a final SP test followed one week later by a final written test.



Larsen et al., 2013

## Types of learning outcomes

- Declarative facts
- Concept classification
- Psychomotor tasks
- Principles
- Problem solving



## WHAT TYPE OF LEARNING DOES YOUR TOPIC FALL UNDER?

## Production Testing

- Questions that require the effortful retrieval and generation of answers
- Not recognition questions such as MCQ
- For example: "Please list all of the elements of the status epilepticus treatment protocol including the timeframe, drugs, doses, and administration rate."
- The principle of desirable difficulties

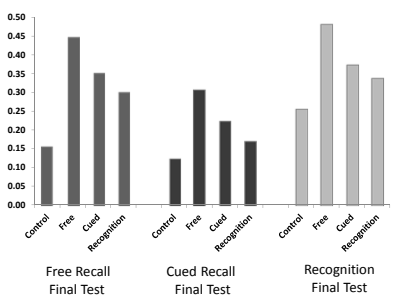
## Production testing

- Students learned topics through three videotaped lectures on art history.
- Randomized to
  - repeated testing with short answers
  - testing with MCQs
  - study
  - no further exposure.
- Retention measured at one month with short-answer test.

Condition	Retention at one month
Short answer tests	47%
MCQ tests	36%
Study	36%
No further exposure	20%

Butler and Roediger, 2007

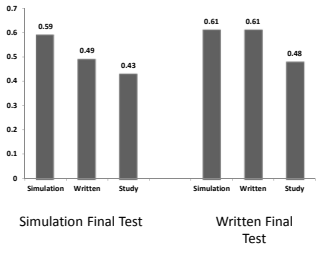
## Why?



Test Type	Control	Free	Cued
Free Recall Final Test	0.15	0.45	0.35
Cued Recall Final Test	0.12	0.30	0.20
Recognition Final Test	0.25	0.48	0.35

Glover, 1989

## Taking a look back . . .



Test Type	Simulation	Written	Study
Simulation Final Test	0.59	0.49	0.43
Written Final Test	0.61	0.61	0.48

## Examples

### Recognition Tests

- Multiple-choice questions
- True/False statements
- Matching

### Production Tests

- Fill-in-the-blank
- Short-answer
- Essay
- Standardized patient encounters
- Manikin simulation
- Clinical patient visits

## WHAT TYPE OF PRODUCTION TESTING FITS BEST IN YOUR CONTEXT?

## Repetition

- Students studied a brief text
- They were then randomized to various regimens of studying or free-recall testing over the text.
- Final recall testing was done at five minutes and one week later.

Condition	Five minute retention
SSSS	.83
SSST	.78
STTT	.71

Condition	One week retention
SSSS	.40
SSST	.56
STTT	.61

Roediger & Karpicke, 2006

## More is better—up to a point . . .

- Participants studied two passages from a general psychology text.
- Initial practice consisted of retrieving the items until all items were correctly recalled.
- Participants randomized to 1-5 follow-up re-testing sessions separated by a week.
- Final testing at four months.

Rawson & Dunlosky, 2011

## What happens when repeated retrieval practice doesn't work?

- Students were either repeatedly tested over or repeatedly studied 30 nephrology flashcards.
- All students recalled the information correctly once and then had four back to back exposures (either through repeated testing or study).
- Final retention measured at one week and six months.

Time	Test	Study
1 week	0.40	0.28
6 months	0.10	0.11

Schmidmaier et al., 2011

## On the other hand . . .

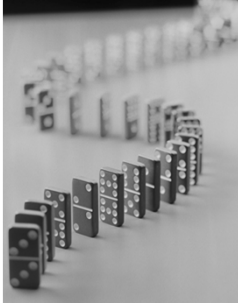
Status Epilepticus Treatment

Myasthenia gravis

Larsen et al., 2009

## Repetition and Spacing

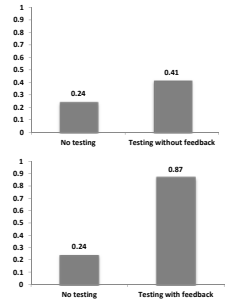
- Multiple opportunities for retrieval practice are needed for long-term retention.
- Although one test is better than none.
- Retrieval practice should be spaced over weeks and months if it is to have an influence for months and years.
- Spacing should be enough to ensure effortful retrieval but not so much that it requires extensive re-learning.



## HOW CAN YOU INCORPORATE REPETITION AND SPACING INTO RETRIEVAL PRACTICE?

## Feedback—the amplifier

- Students were tested with 40 general knowledge questions.
- Half questions provided feedback and half without.
- Subjects then took a 60 question final test that included items that had not been tested.

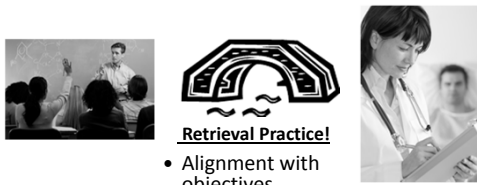


Condition	Score
No testing (without feedback)	0.24
Testing without feedback	0.41
No testing (with feedback)	0.24
Testing with feedback	0.87

Butler, Karpicke, & Roediger, 2008

## HOW CAN YOU INCORPORATE FEEDBACK IN YOUR EDUCATIONAL CONTEXT?

## Summing it all up ...



**Retrieval Practice!**

- Alignment with objectives
- Production testing
- Repetition
- Spacing
- Feedback