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Evidence-Based Instruction: What Works, What Doesn't

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Does reading help?

I recommend it!

But reading leads to an illusion of learning

- sham reading
- reading without understanding

Does highlighting per se improve learning?

"On the basis of the available evidence, we rate highlighting and underlining as having low utility (p. 21)"

Dunlosky, Rawson, Marsh, Nathan, & Willingham (2013)

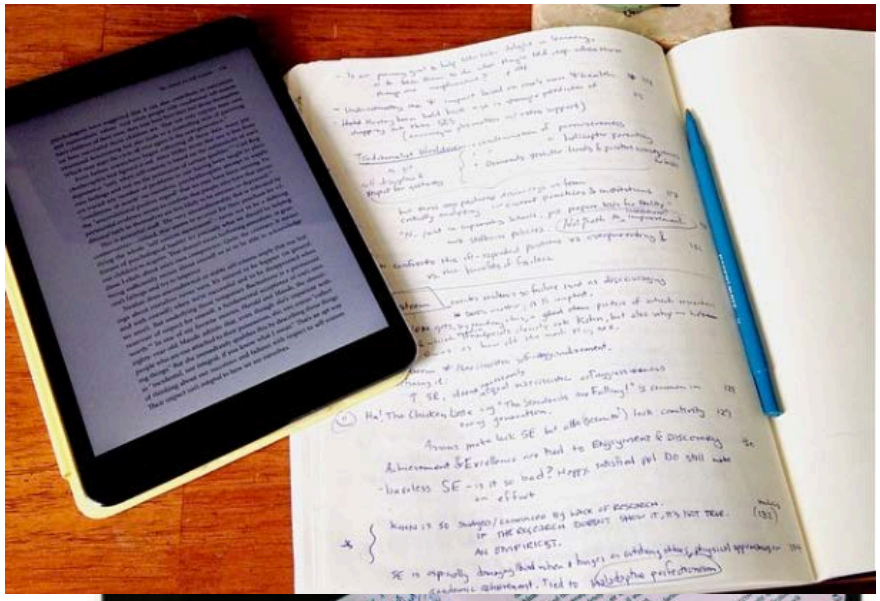
Some researchers quibble with this

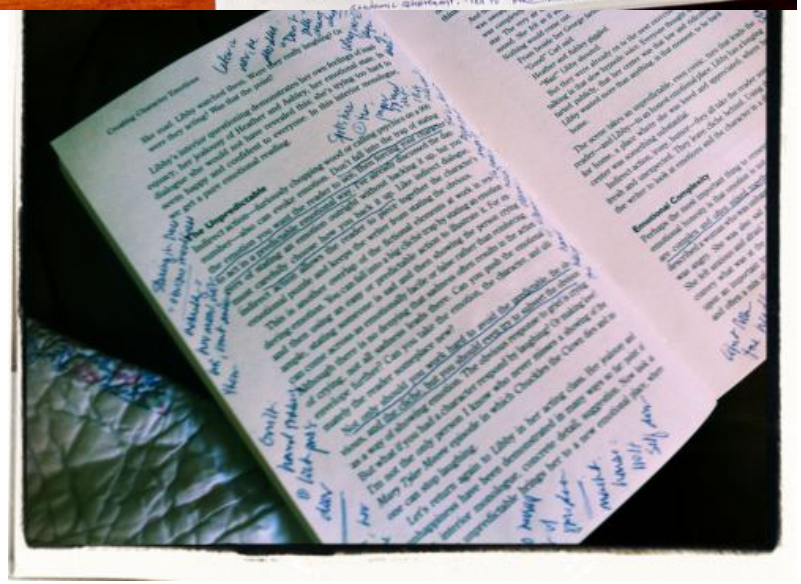
The problem is that students can highlight without understanding

There are three main types of fault, all of which may cause an interplate earthquake: normal, reverse (thrust) and strike-slip. Normal and reverse faulting are examples of dip-slip, where the displacement along the fault is in the direction of dip and movement on them involves a vertical component. Normal faults occur mainly in areas where the crust is being extended such as a divergent boundary. Reverse faults occur in areas where the crust is being shortened such as at a convergent boundary. Strike-slip faults are steep structures where the two sides of the fault slip horizontally past each other; transform boundaries are a particular type of strike-slip fault.

A different approach: Self-Explanation

Students explain main points in their own words





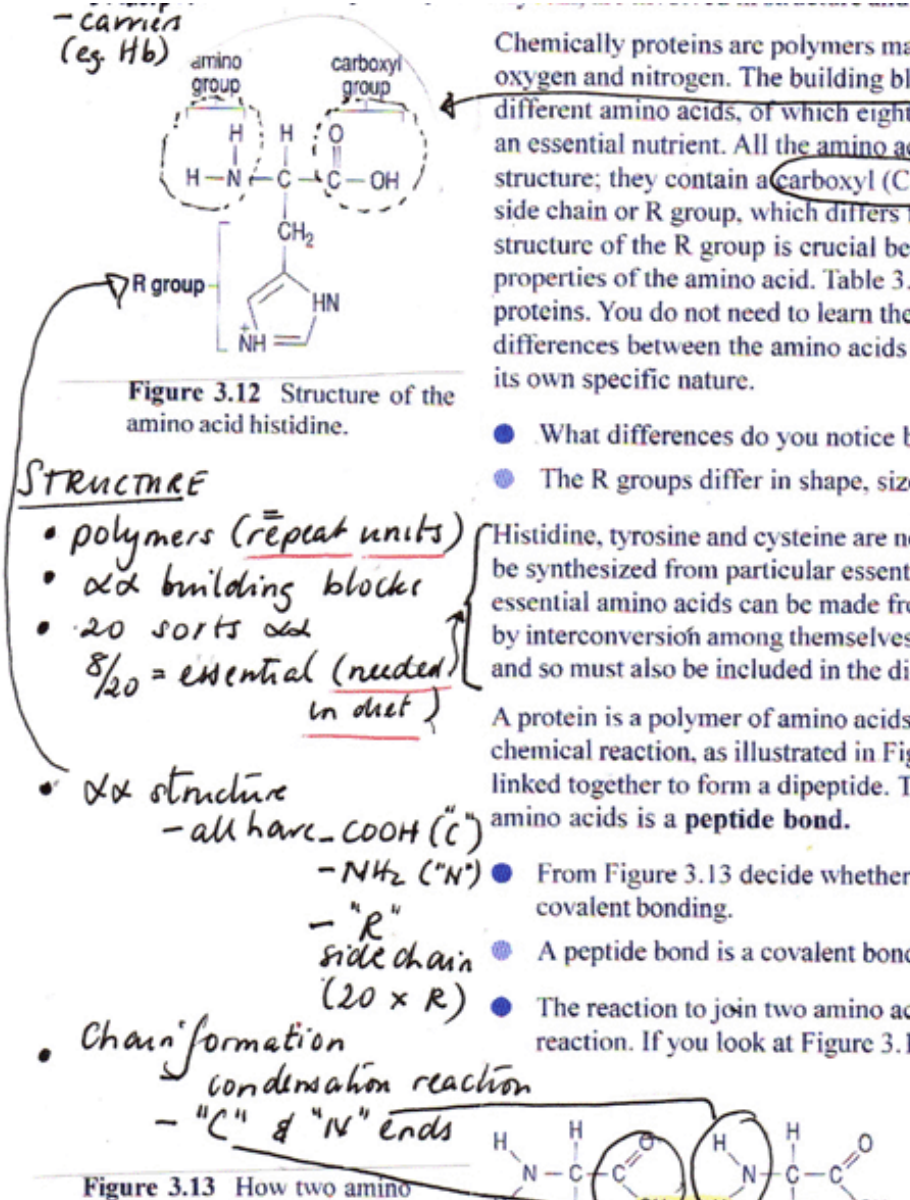


Figure 3.12 Structure of the amino acid histidine.

Chemically proteins are polymers ma
oxygen and nitrogen. The building bl
different amino acids, of which eight
an essential nutrient. All the amino ac
structure; they contain a carboxyl (C
side chain or R group, which differs
structure of the R group is crucial be
properties of the amino acid. Table 3.
proteins. You do not need to learn the
differences between the amino acids
its own specific nature.

- What differences do you notice b
- The R groups differ in shape, siz

Histidine, tyrosine and cysteine are n
be synthesized from particular essent
essential amino acids can be made fr
by interconversion among themselves
and so must also be included in the di

A protein is a polymer of amino acids
chemical reaction, as illustrated in Fig
linked together to form a dipeptide. T
amino acids is a **peptide bond.**

- From Figure 3.13 decide whether
covalent bonding.
- A peptide bond is a covalent bond
- The reaction to join two amino ac
reaction. If you look at Figure 3.1

Figure 3.13 How two amino

Lots of good data support Self-Explanation

Example

RCTs show that

reading with self-explanation > just reading (even if total time equated)

(For recent reviews, see Dunlosky et al., 2013; Roediger & Pyc, 2012)

Retrieval Practice (aka self-testing)

Student tries to recall information and then sees correct answer

Flashcards

Retrieval practice is more than just flashcards

Examples

- Writing requires recall of spelling and syntax
- Solving math problem requires recall of procedures
- Answering Spanish teacher requires recall of vocabulary, grammar

Many RCTs have found benefits of Retrieval Practice

Benefits found under a wide range of scenarios even when total time equated

Examples

Reading and retrieval practice > Reading and rereading

Reading and retrieval practice > Reading and studying

(For reviews, see Dunlosky et al., 2013; Roediger & Pyc, 2012)

Implications

- Students should test themselves
- Teachers should give lots of quizzes and/or practice questions

Modal response to advocacy for retrieval practice:
"But I teach critical thinking – not facts!"

Critical thinking is not sufficient.

Students need knowledge.

Answer Feedback

Student see correct answer soon after test question

Suggestion: Post test answers before posting test scores

Post answers outside classroom

Email answers to students

Discuss exam questions in class

What about quantitative courses? Math, Stats, Physics, Chemistry

Most sets of practice problems devoted to the same topic

NAME _____ DATE _____ PERIOD ___

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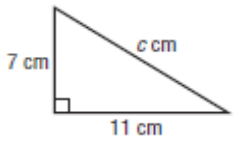
Homework Practice

The Pythagorean Theorem

Find the missing measure of each triangle. Round to the nearest tenth if necessary.

1.



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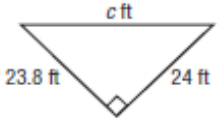

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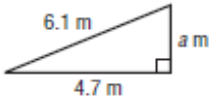

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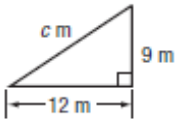

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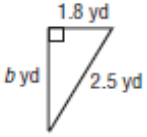

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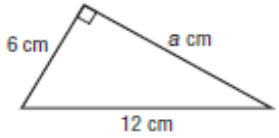


7. $a = 3.3$ in., $b = 5.6$ in.

8. $b = 2.9$ mm, $c = 4.4$ mm

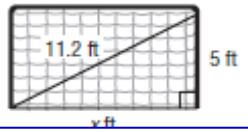
9. $a = 21$ yd, $c = 29$ yd

10. $a = 2\frac{1}{5}$ ft, $c = 4\frac{2}{5}$ ft

11. $b = 7\frac{1}{4}$ in., $c = 7\frac{3}{4}$ in.

12. $a = 6\frac{1}{2}$ yd, $b = 10$ yd

13. SOCCER Find the width of the soccer goal. Round to the nearest tenth.



Students know the strategy for each problem before they read the problem!

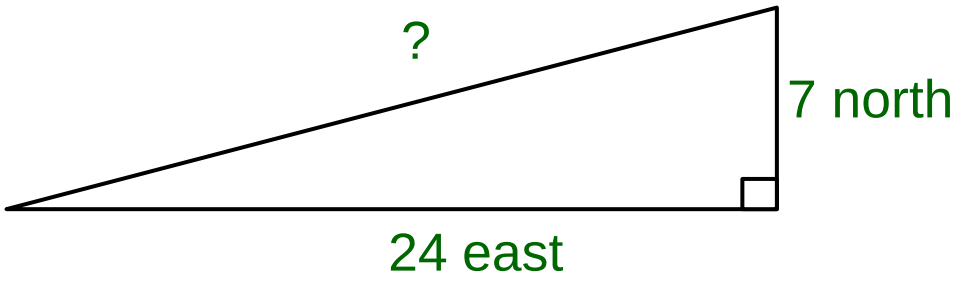
But students must learn to choose a strategy – not just execute it

Example

Zoe kayaks 24 km east and then 7 km north.

How far is she from her starting point?

1. Choose strategy — Pythagorean Theorem



2. Execute strategy

$c^2 = 24^2 + 7^2$

$c = 25$ km

Yet students must choose the strategy during a …

cumulative final exam

standardized test

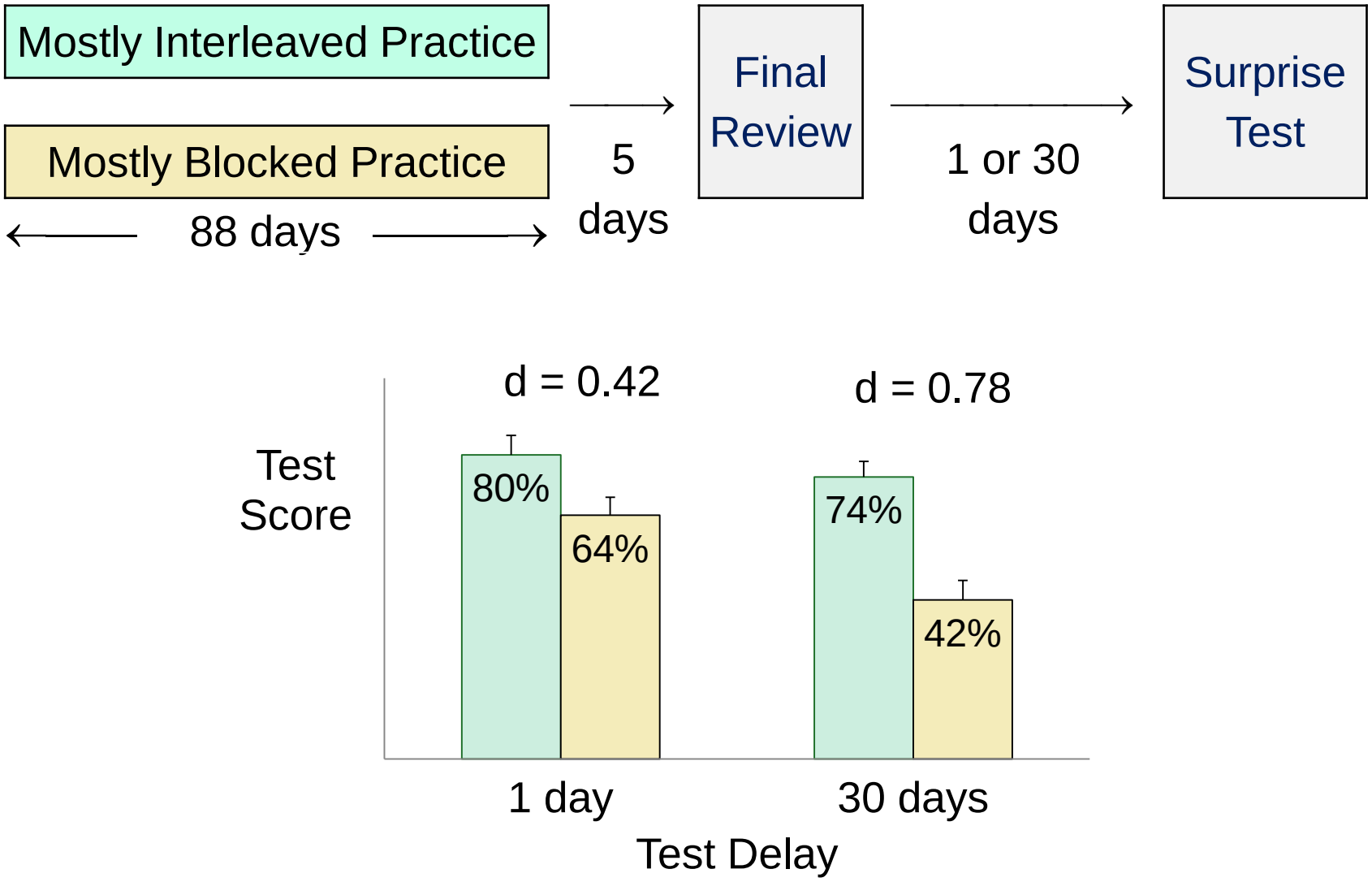
subsequent science course

(and rightly so)

Remedy: Interleaved Practice

1. Graph the equation. $y = 3x + 1$
2. Find the area of a circle with radius π.
3. Solve for *x*. $9(1 + x) = 5(x + 9)$
4. Find the slope of a horizontal line.
5. Simplify. $(-5)^3$
6. Simplify. $3\ (4 + 2)\ -\ 7$
7. Ben's cab ride cost $50. He also gave an 8% tip. Find the total cost.
8. Ben's ride of 16 miles took 40 min. Find his average speed in miles per hour.

Interleaved practice boosts test scores, especially in the long run



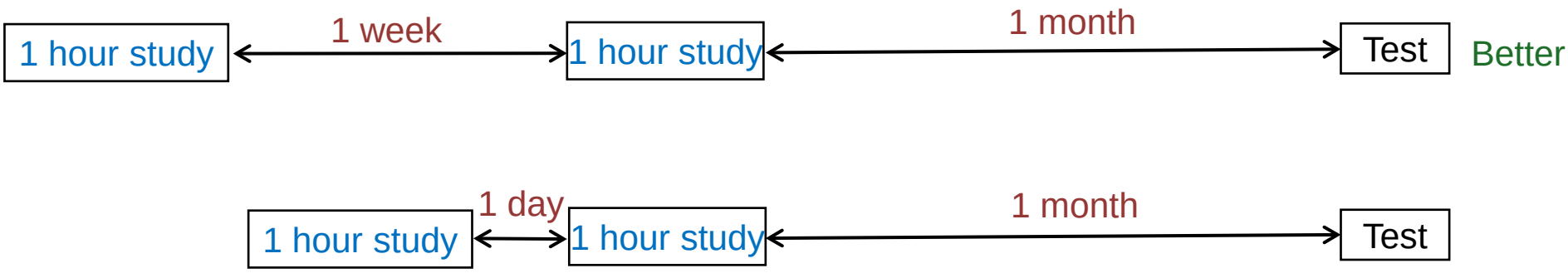
(Rohrer, Dedrick, & Stershic, 2015)

Learning is fine, but what good is learning if students forget?

Spacing

distributing a given amount of study effort across a longer period of time

The spacing effect.



Longer spacing gaps → Greater test scores

Spacing provides far more bang for the same buck

Spacing effect found under a wide range of scenarios

Spacing effect is probably the largest and most robust learning strategy

(when total time equated)

(e.g., Dunlosky et al., 2013; Roediger & Pyc, 2012; Rohrer & Pashler, 2010;

and dozens and dozens more)

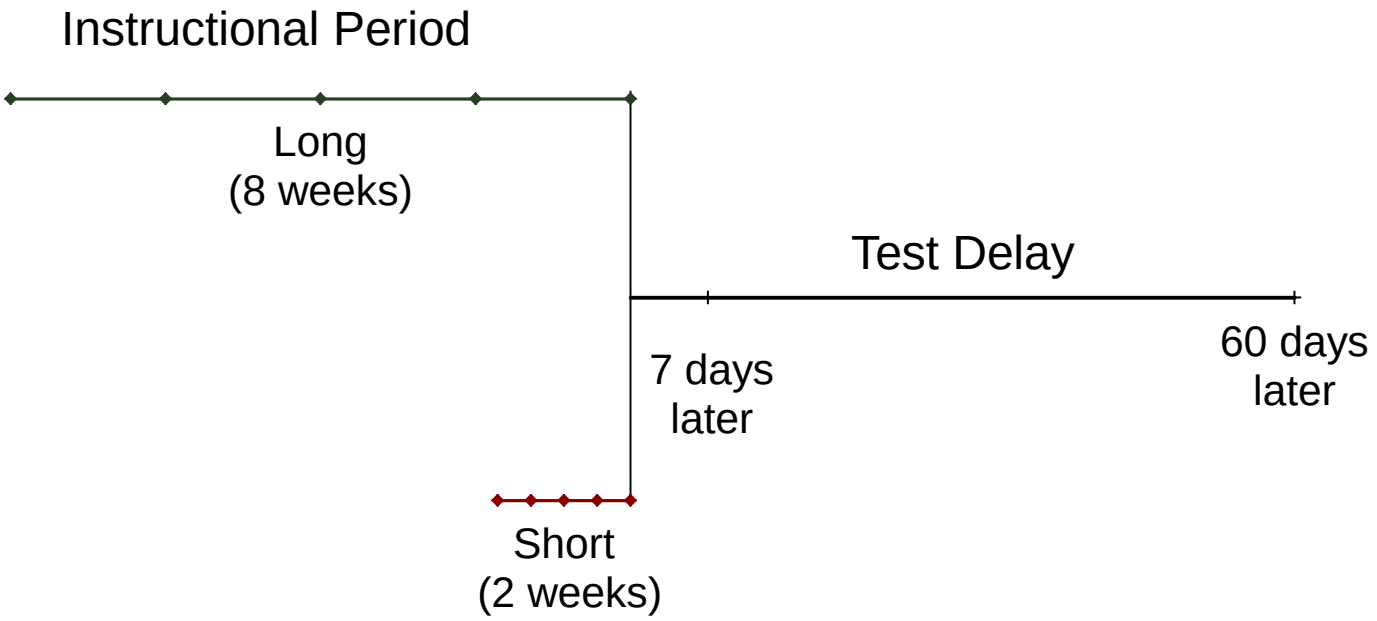
Spacing is not useful in the short-term

Classroom RCT

English-learning students learn to correct non-grammatical sentences

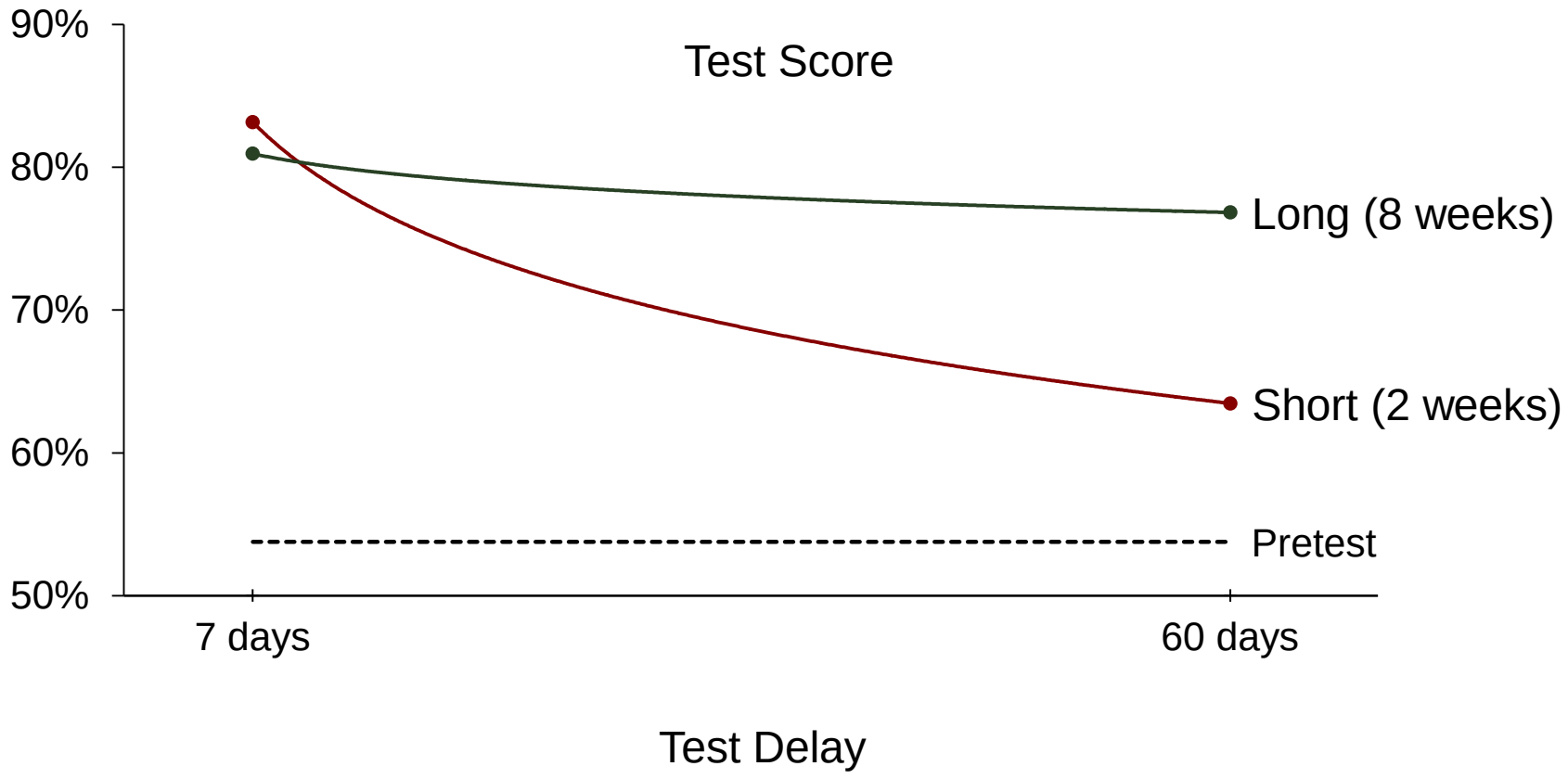
I have seen the movie with my brother last week

How long did you sit in this classroom so far this morning?



Bird, S. (2010). *Applied Psycholinguistics, 31*, 635-650.

Results



Bird, S. (2010). Effects of distributed practice on the acquisition of second language English syntax. *Applied Psycholinguistics, 31*, 635–650

So cramming is ideal for learners seeking only short-term learning

And most students care only about the short term

Obvious implications of spacing effect

Schools shouldn’t offer short courses (e.g., Summer Session A)

Instructors should give cumulative assignments and cumulative exams

Matching Instruction to a Student's Learning Style

Student learns better if instructional method matches student's learning style.

Example

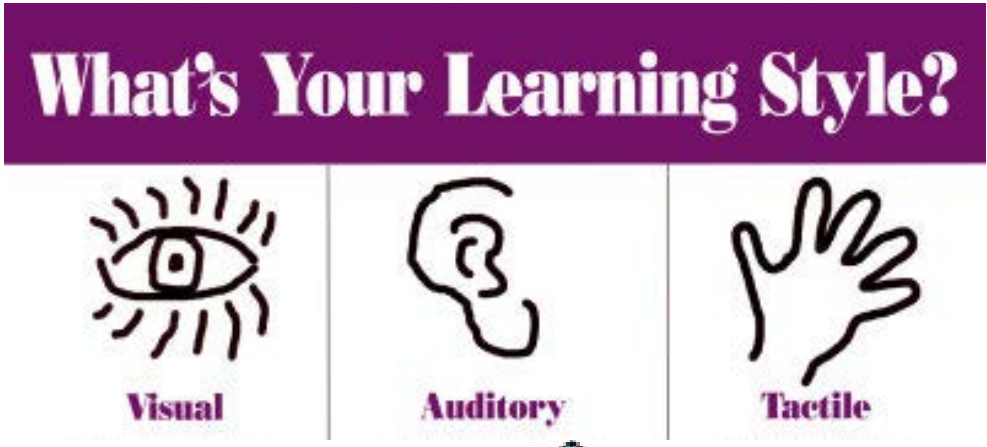
First, students are classified by style (e.g., visual vs. verbal)

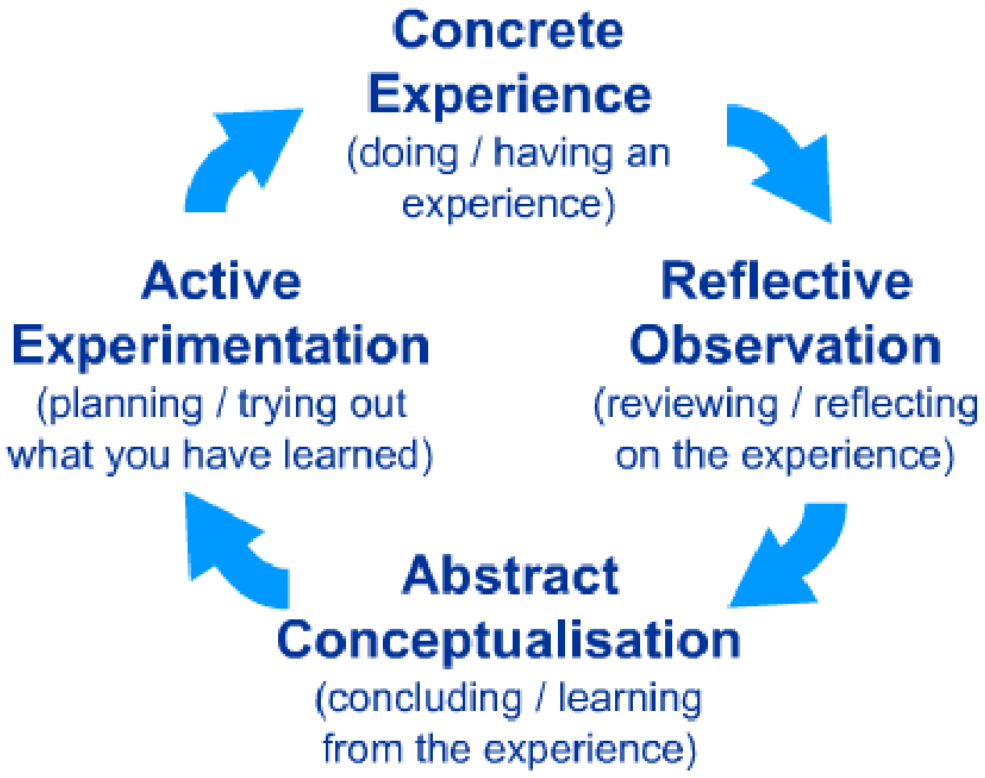
Then students receive instruction tailored to their style.

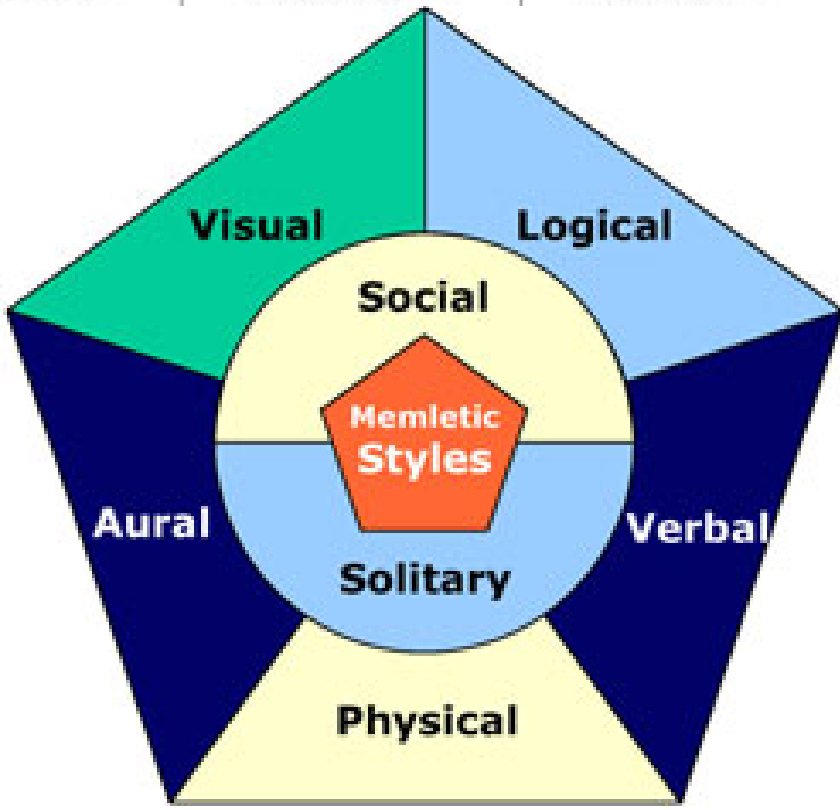
Learning style approach is popular

Advocated in thousands of articles.

School systems love it.







Learning style approach costs many tax dollars

Assessments

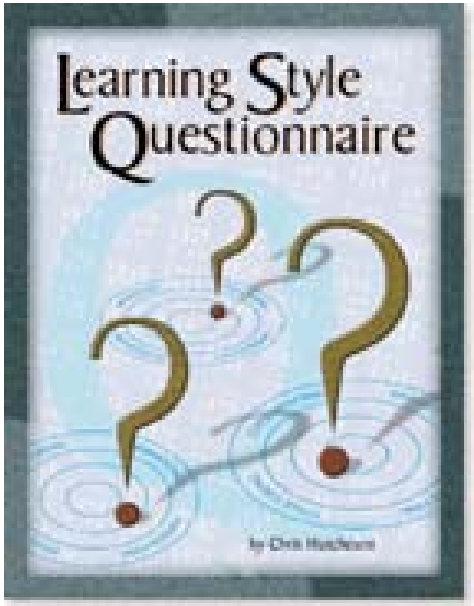
Customized instruction

Teacher training

visual * aural * read/write * kinesthetic

VARK®

a guide to learning styles



The Learning Styles idea is intuitively appealing

The following are true statements

Many students have a preferred learning style (visual, auditory, etc.)

Ms. A might excel on visual but not verbal tasks while Ms. B shows the reverse

Sometimes students benefit from multiple styles (e.g., text and diagram)

But none of the above supports style-tailored instruction

RCTs find no evidence for “style-based instruction”

Instead, optimal approach varies by topic.

Example

In geometry class, all students do best with visual instruction.

(Coffield et al., 2004; Pashler, McDaniel, Rohrer, & Bjork, 2009; Rohrer & Pashler, 2012)

Summary

Strategy	Efficacy
reading	good, but only if material is understood
highlighting/underlining	poor
self-explanation	good
retrieval practice	good
answer feedback	good
interleaving	good for quantitative courses
spacing	good unless short-term learning is goal
learning style	no evidence