



Science of Learning for Teachers

FACULTY DEVELOPMENT WEEK
WORKSHOP

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Let's start with some discussion questions:

Think in your mind/write down for yourself:

- What does it mean when a student encounters difficulty through the learning process for your class? How do you respond?
- What does it mean when a student makes an error in your class? How do you respond?

Outline

1. The New Theory of Disuse
 - a. Desirable Difficulties
2. Metacognition and Fluency
3. Testing as a Desirable Difficulty
4. Errors and Learning

Two strengths of memory

Storage strength/Availability: how well learned (entrenched)

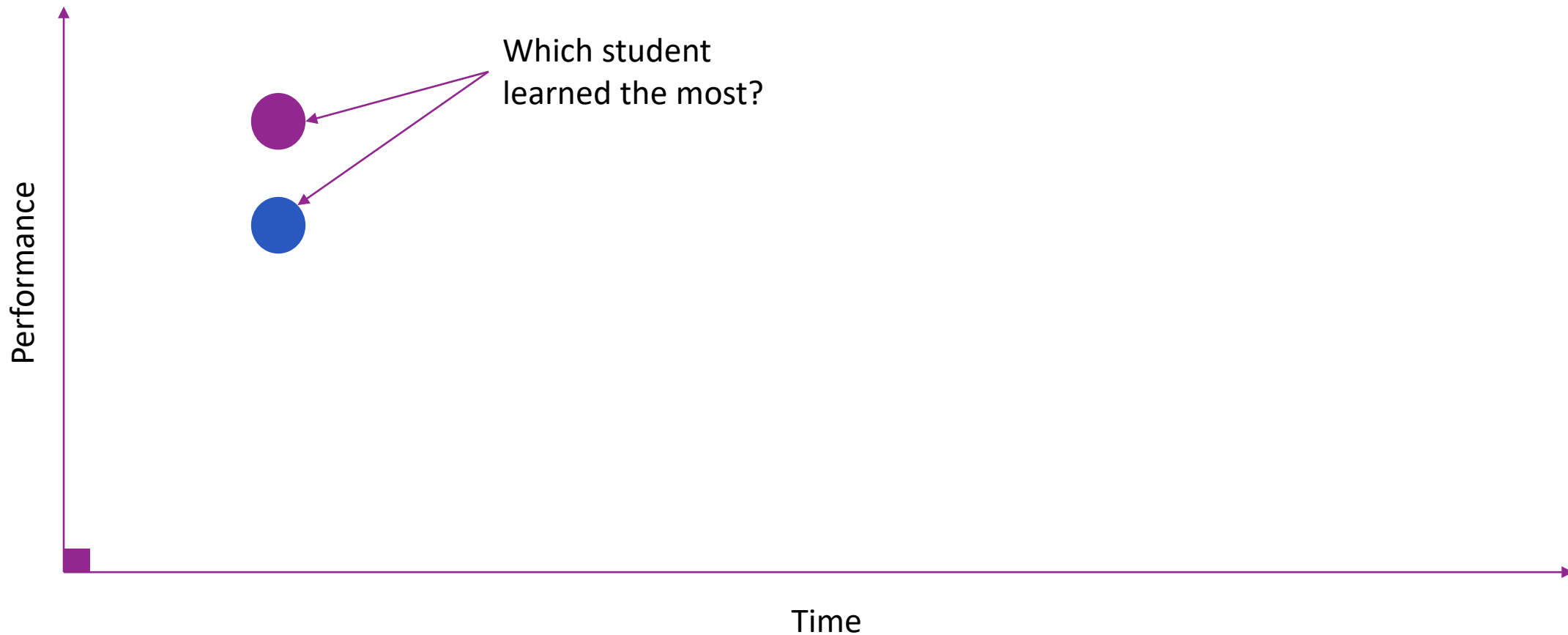
- Functionally Limitless
- Never lost
- Enhances learning/prevents forgetting

Retrieval strength/Accessibility: how accessible (at the moment)

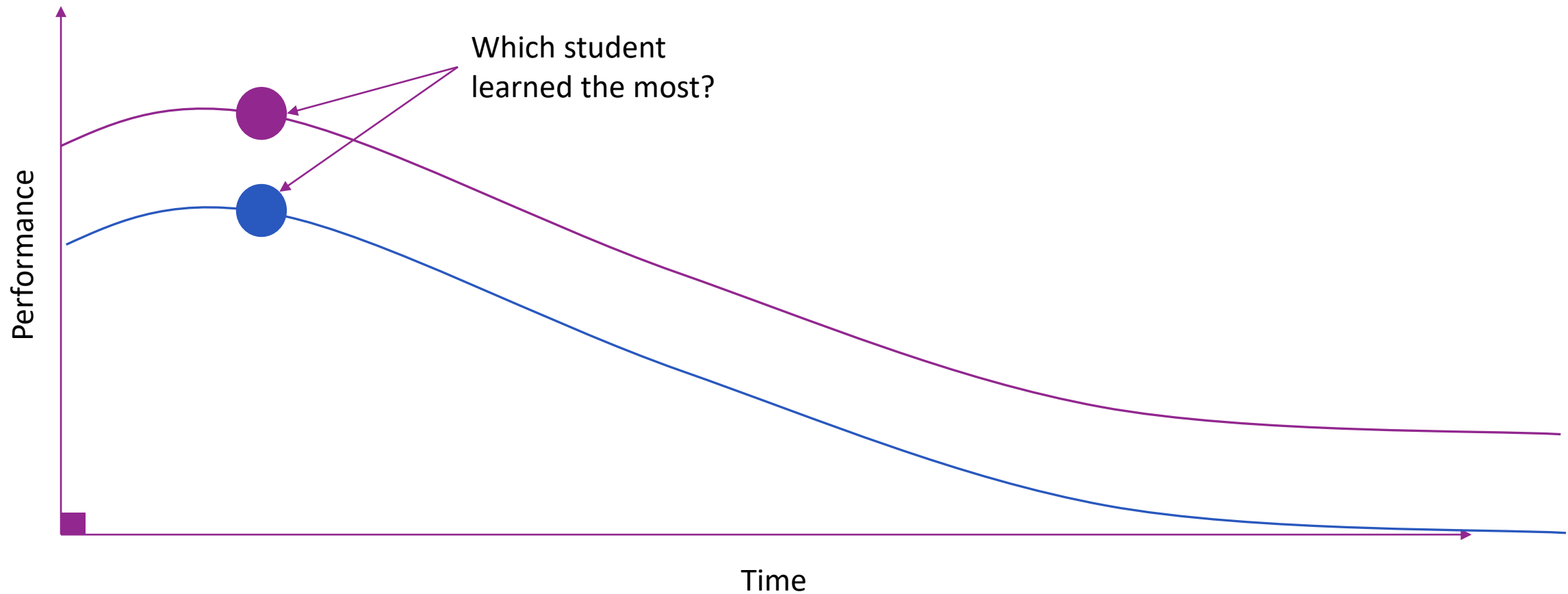
- Severely limited
- Heavily cue dependent
- Affected by strength of other items

New Theory of Disuse (Bjork & Bjork, 1992)

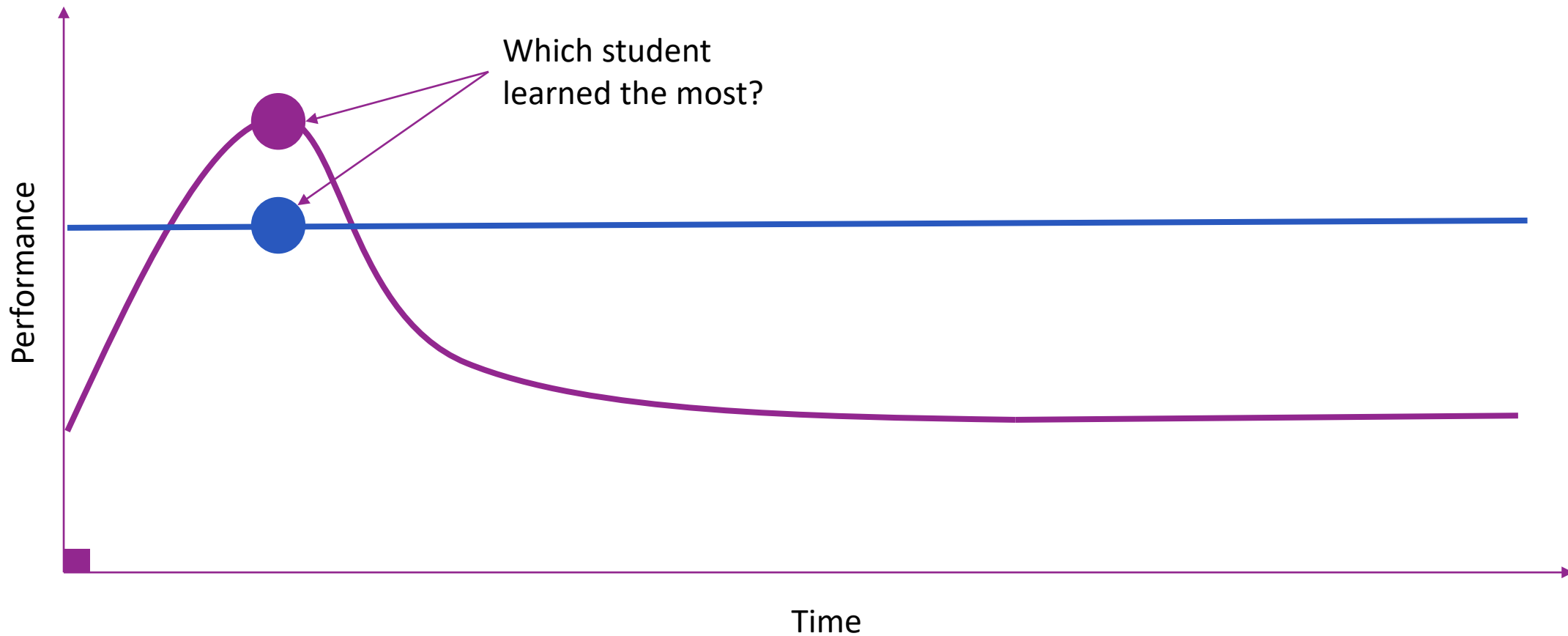
Learning and Performance



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Learning and Performance

Performance:

- We measure student performance through tests, papers, and assignments.
 - Reflects *retrieval strength*.

Learning

- We **infer** student learning (often inaccurately) through their performance.
 - Reflects *storage strength*.

Desirable difficulties

Learners tend to avoid difficulty during learning, instead opting for learning strategies that feel easier in the moment.

- Metacognitive Illusion

Engaging in more difficult study strategies can be incredibly powerful for learning.

Desirable difficulties (testing; pretesting; spacing; interleaving; variability; etc)

- Difficult: impede performance initially
- Desirable: enhance performance at a delay and in new contexts

Metacognition and Fluency

Metacognition: thinking about thinking

- Students (and everyone else too!) tend to believe a lot of inaccurate things about memory and cognition!

Fluency

- The ease with which information is processed
- If information is currently available to you, you can easily overestimate how easily you'll access that information later

Metacognition and Fluency

Tasks are judged as easier when the answer is available

Participants overestimate ease of completing anagrams when the answer is available:

- FSCAR -> SCARF
- RMADE -> ?

Try humming or tapping out a tune on a table to a friend

- How likely are they to guess it?



Newton (1990, unpublished dissertation)

Assigned participants to 2 roles: “tapper” or “listener”

Tapper: choose from a list of 25 well-known songs (e.g., Happy Birthday, Star Spangled Banner)

Listener: guess the song

Tappers predicted success of listeners– ~50%

Listeners actual performance– 2.5%



Teaching with fluency

Presumably, we are all experts in our respective fields!

- In this case, fluency is a GOOD indicator that WE have strong knowledge structures.
- BUT, what about using fluency as a cue for how easy it is to learn something new in the first place???

Fluency is a misleading cue of student knowledge!

- Makes it very difficult for us to understand/remember how hard it is to learn something in the first place

Tests, quizzes, exams as desirable difficulties



Traditionally used for assessment- not as learning events



However- tests do more than measure memory- they modify and enhance it!

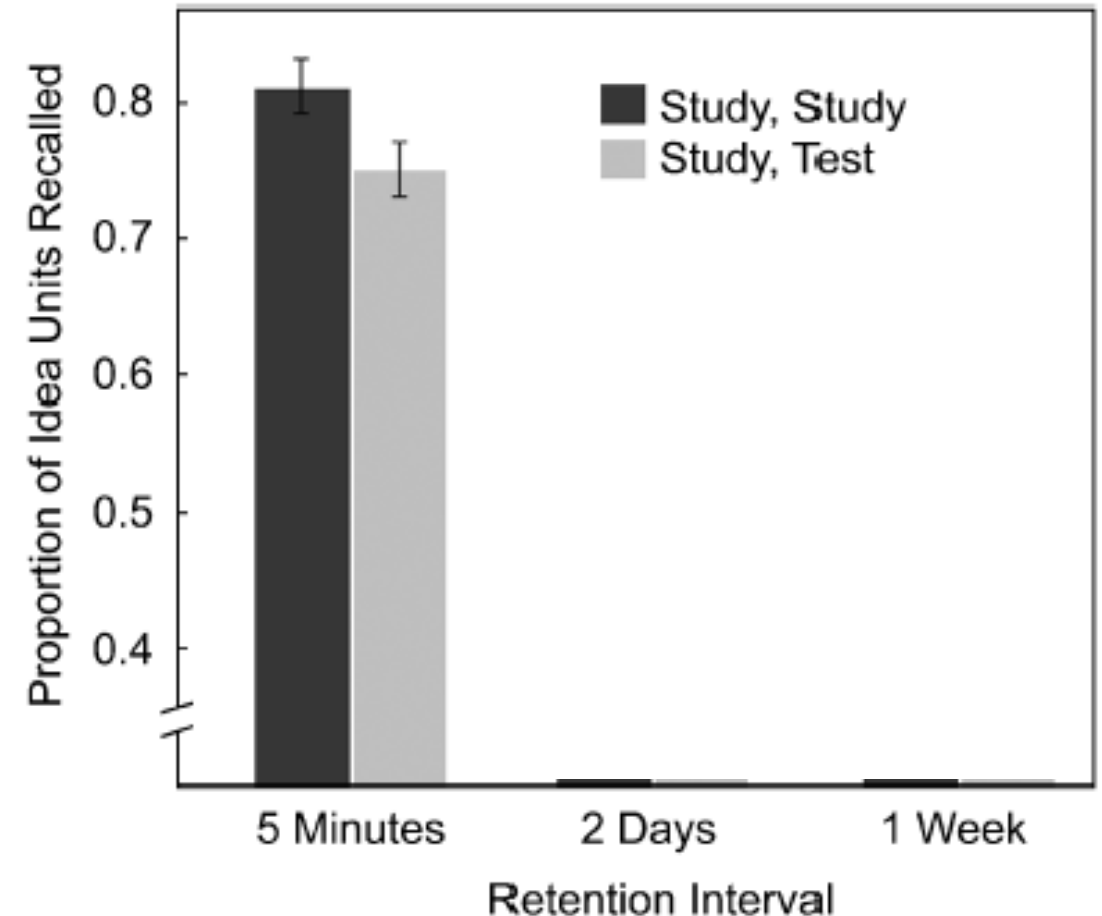


The **Testing Effect**: engaging in retrieval processes leads to better later retrieval

The testing effect

Roediger and Karpicke 2006

- Learners read two prose passages
- Learning condition (within subjects)
 - 7 minutes study; 7 more minutes study
 - 7 minutes study; 7 minutes free recall
- Retention interval (between subjects)
 - 5 minutes
 - 2 days
 - 1 week



What can testing look like?



Retrieval practice can be defined as pulling information out of one's memory

Can be compared with re-reading/re-watching lectures



Not just an assessment tool!



Asking questions in the classroom and making sure that students are answering them

careful of Fisheye Syndrome



Encouraging students to make flashcards and engage in other retrieval practice strategies on their own.



Teaching! (good news for us!) Teaching is extremely powerful for learning for many reasons, one of which being that it forces us to engage in retrieval practice.

Thoughts on how to implement this for students in the classroom?

Tips for Effective Retrieval Practice

- A. Begin** each study session with retrieval practice
 - Show you what information to prioritize
 - Boost learning
- B. Guess** if you're not sure
- C. Match** type of thinking involved in your retrieval practice to the type of thinking you'll have to do on the test
- D. Get **feedback****, i.e., validate answers
 - Improve your metacognition
 - Boost learning
- E. Repeat:** correctly retrieve information about the same concept about 3 times each study session
- F. Space** out your retrieval practice of the same concepts over multiple days

Other forms of desirable difficulties

Pretesting-

- Taking tests before the content is learned

Spacing-

- Increasing time between study sessions
- As opposed to cramming

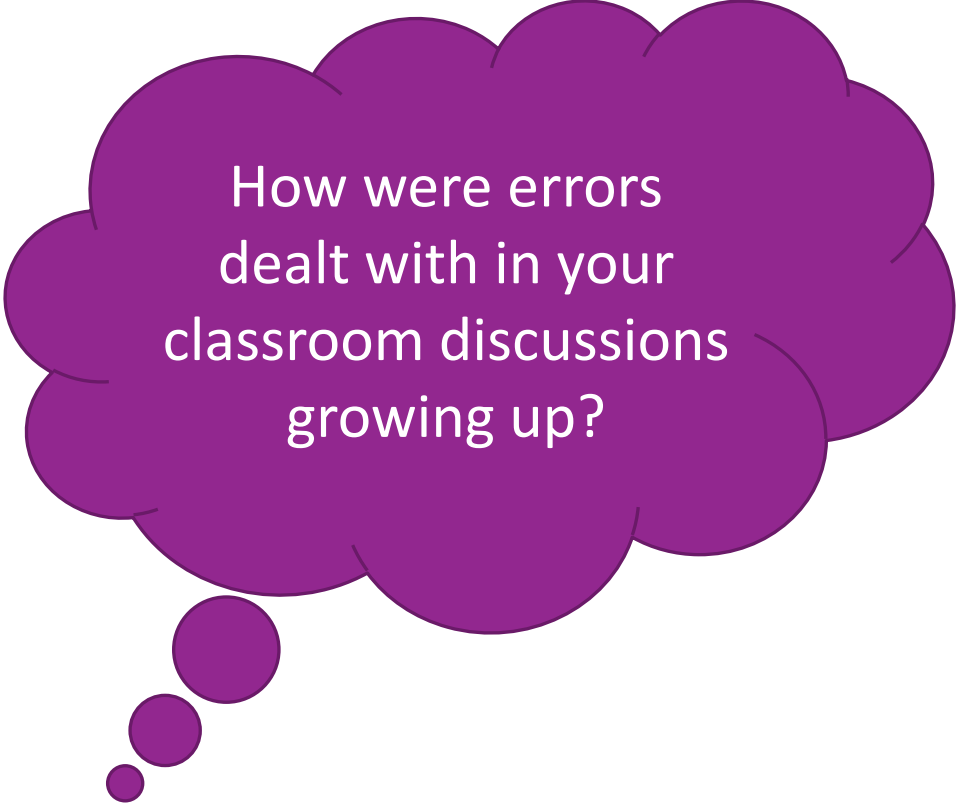
Interleaving-

- Mixing related/easily confusable concepts together during a study session

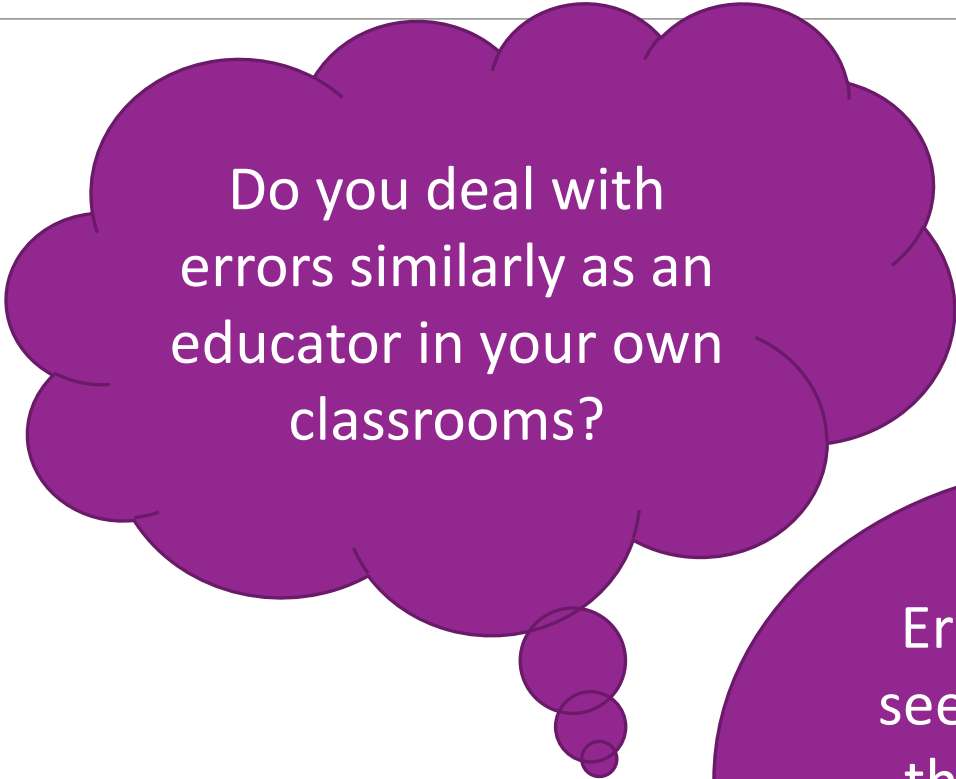
Variability

- Changing study strategies during the learning process

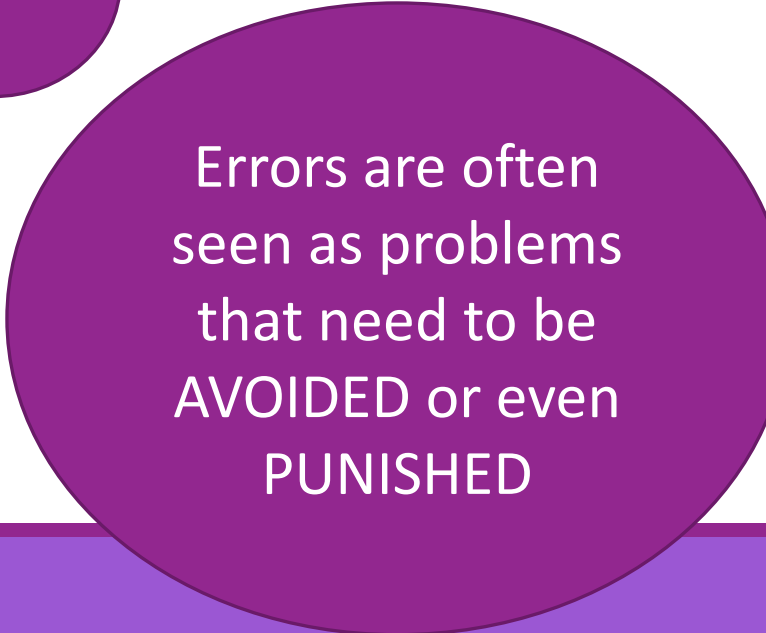
Learning through errors



How were errors
dealt with in your
classroom discussions
growing up?



Do you deal with
errors similarly as an
educator in your own
classrooms?



Errors are often
seen as problems
that need to be
AVOIDED or even
PUNISHED

Learning through errors

Teachers often punish students for making errors during learning.

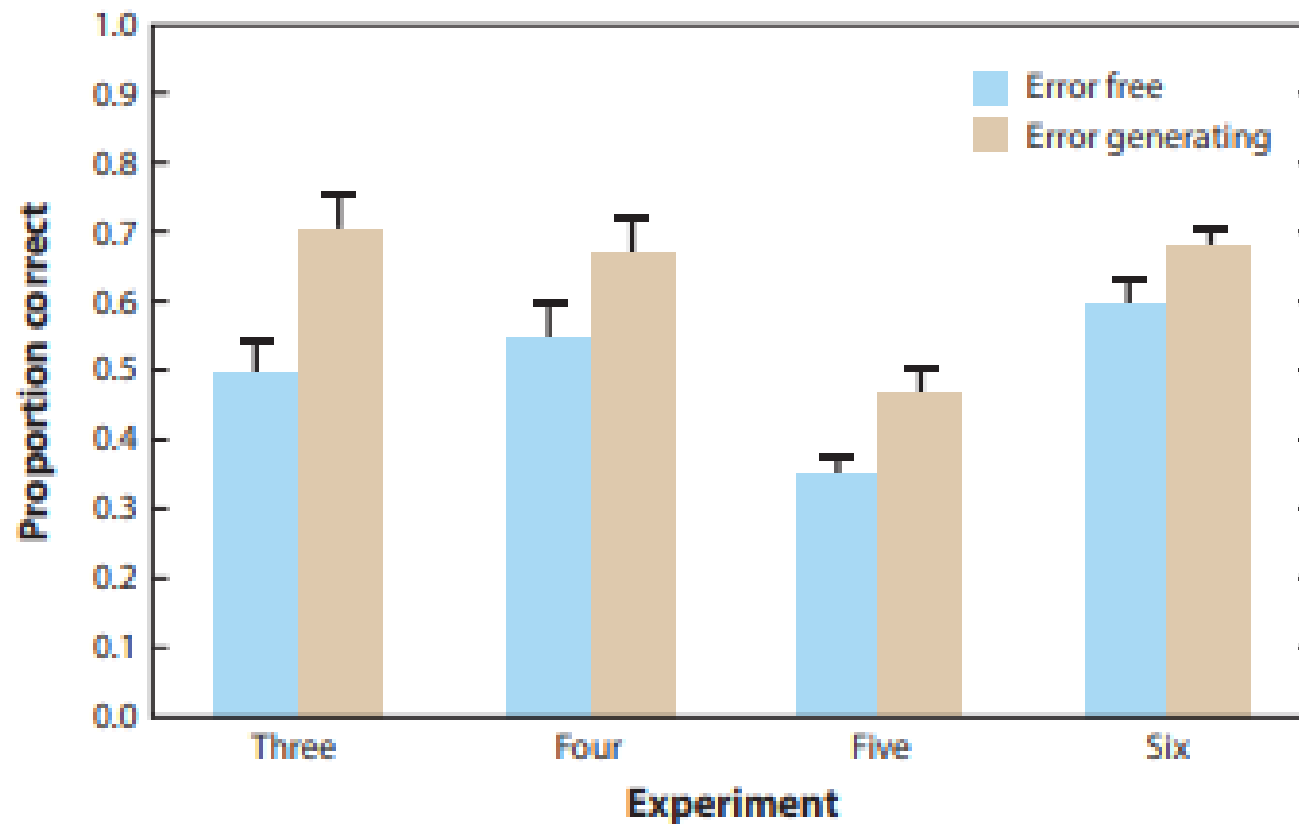
There is a concern that the act of making an error will reinforce the incorrect information in learners' memory

Two types of errors:

- Omission
- Commission

However, as long as errors are corrected in some way, they can be very beneficial to learning!

Error-generating vs. error-free study



The hypercorrection effect

Even high confidence wrong answers can lead to improved learning

In fact, these are *more* likely to improve learning than low confidence answers

People *hypercorrect* these high confidence wrong answers

How is this possible?

- Surprise
- Stronger knowledge structures

Other benefits of errors

Errors help us as teachers understand what concepts students are struggling with or what may need to be re-explained

Offsetting overconfidence for students

In environments that allow for errors, students make more attempts which means more generative processes



Big Picture: Errors

Making errors is GOOD!!! Making errors is a sign that you (and/or your students) are engaging in retrieval and pushing yourself. Feedback is critical, though!

Think carefully about how you address errors in the classroom.

Discussion qs:

- What are some concrete ways teachers can address student errors?
- If students making errors during the learning process is a good thing, how can we encourage or allow space for errors in our classrooms?

Thanks for listening!

ANY REMAINING QUESTIONS?