



UNLOCKING *Learning*

An Introduction to the
Science of Learning



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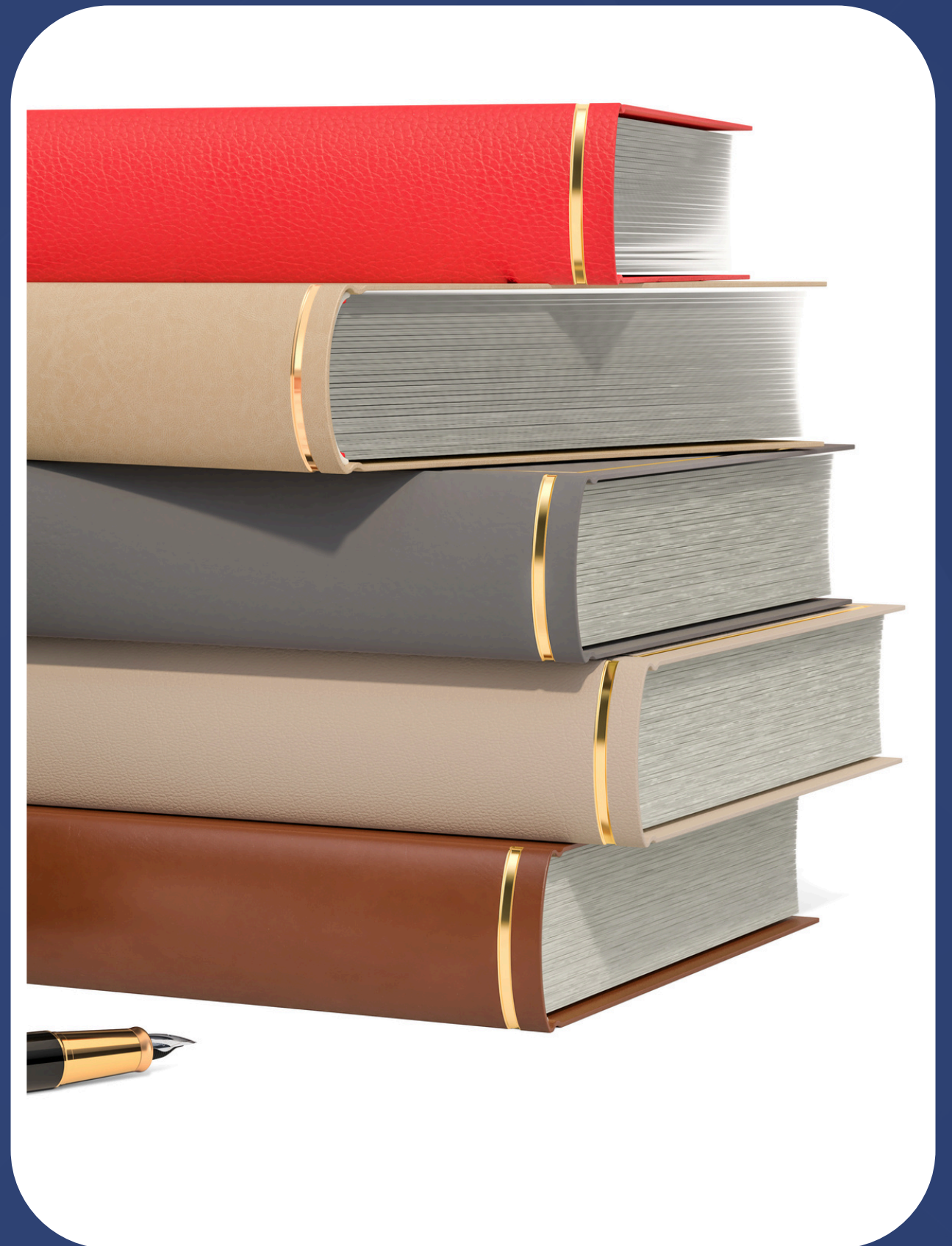


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WHAT DO YOU **REMEMBER?**

1. What was the last thing you learned in a professional development session?
2. Can you explain it without looking at notes?
3. Have you used it recently?



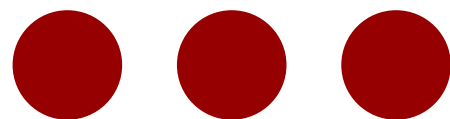
**THE PROBLEM ISN'T THAT
STUDENTS AREN'T LEARNING;
IT'S THAT THE LEARNING
DOESN'T STICK.**



WHAT IS THE **SCIENCE OF LEARNING?**

An interdisciplinary body of research from cognitive psychology, neuroscience, education, and related fields that examines how people

- acquire,
- retain, and
- transfer knowledge.



Teaching or **LEARNING?**

Question: Have you ever heard someone say, “They never taught us that in school!”



A more honest statement might be:
“I didn’t learn that in school.”



TRADITIONAL **ASSUMPTION**

Teaching → Learning



EVIDENCE-BASED **REALITY**



Teaching → Processing → Encoding → Storage → Retrieval → Transfer

LEARNING & INTENTIONAL DESIGN

Learning occurs inside the learner's mind, not just because content is presented.

- Intentional instructional design
- can increase the likelihood that
- learning will occur.



FOUNDATIONAL
RESEARCH

WORKING MEMORY IS LIMITED

Implications:

- Avoid overwhelming students
- Chunk information
- Reduce unnecessary distractions



FORGETTING IS NORMAL

Learning + Time = Recall declines

Retrieval bumps it back up.

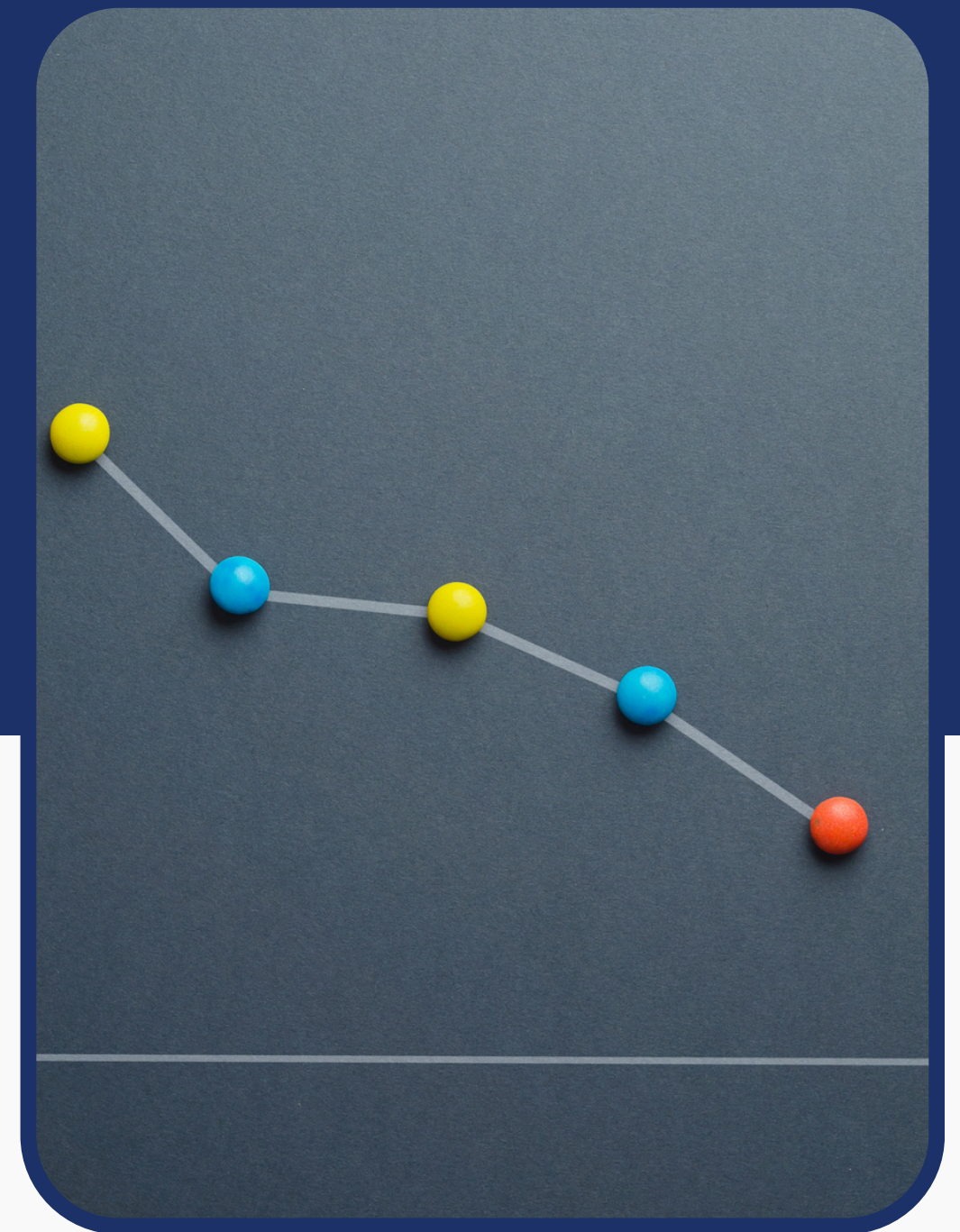


Our brains are designed to forget information that isn't used.

Learning is enhanced when students repeatedly retrieve and revisit important ideas over time.

Forgetting isn't failure.

It creates the opportunity for stronger learning.





1. WORKING MEMORY

We focus on and actively process information in our mind.



2. LONG-TERM MEMORY

Information is encoded and stored for future use.



3. RETRIEVAL

We access and bring stored information back to mind.



4. TRANSFER

We apply what we know to new situations and contexts.

BUILDING LONG TERM MEMORY

Deeper learning happens when we help move knowledge from working memory into long-term memory, and then repeatedly retrieve and apply that knowledge, strengthening that knowledge pathway.



A continuous cycle that strengthens learning and builds understanding.

*Image created with Canva Magic assistance.



RETRIEVAL STRENGTHENS LEARNING

Learning is strengthened when students bring information to mind.

Examples:

- Exit tickets
- Cold call retrieval
- Low-stakes quizzes



AN IMPORTANT FACTOR INFLUENCING LEARNING IS WHAT STUDENTS ALREADY KNOW.

PRIOR KNOWLEDGE
MATTERS

Examples:

- Activating background knowledge
- Concept maps
- Bridging misconceptions



LEARNING REQUIRES **EFFORT**

Struggle can be productive,
but only in the correct phase
of the learning cycle.

Examples:

- Interleaving
- Spacing
- Retrieval practice



IS IT THE SCIENCE OF LEARNING



SCIENCE OF LEARNING IS:

Evidence-informed

Focused on long-term learning

About cognition

Research-based

Concerned with retention and transfer



SCIENCE OF LEARNING IS NOT:

A collection of trendy strategies

Focused on immediate performance

About “learning styles”

Based on intuition alone

Concerned only with engagement

TRUE OR **NEUROMYTH?**



Learning Styles: "Students learn best when teaching matches their preferred style"



Edgar Dale's Cone of Experience: "We remember 10% of what we read, 90% of what we do."



Left-Brain-Right-Brain Dominance: "She's a right-brained learner, so she struggles with analytical tasks."



We Only Use 10% of Our Brains: "Imagine what students could accomplish if they learned to use the other 90% of their brains."



ALL ARE **NEUROMYTHS**



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CONNECTION TO **UNDERSTANDING BY DESIGN**



What should students learn?



How can we help them retain and transfer that learning?

The 3 Stages of Understanding by Design

Stage 1

Identifying Desired Results

Stage 2

Determining Acceptable Evidence

Stage 3

Planning Learning Activities and Experiences



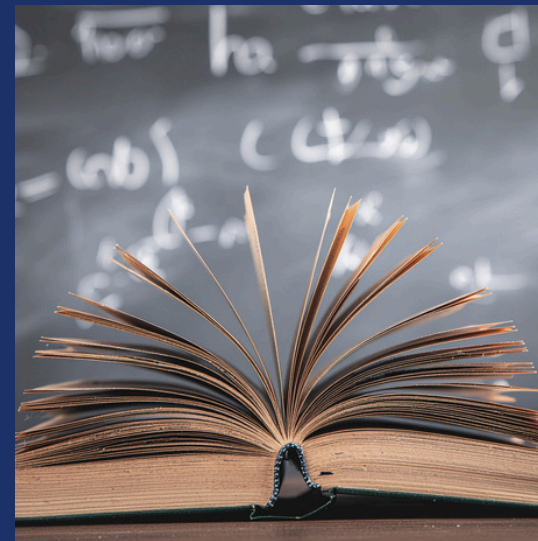
Stage 1

Identifying Desired Results

What knowledge and skills are most important for students to remember and transfer months or years from now?

- Focus curriculum on high-value knowledge
- Reduce overload from excessive content coverage
- Emphasize durable learning goals

How the Science of Learning Strengthens Stage 1



Distinguishes core knowledge from "nice-to-know" content



Prioritizes concepts student must retain long-term



Identifies pre-requisite knowledge needed for future learning

Stage 2

Determine Acceptable Evidence

Does our assessment require students to retrieve, apply, and transfer learning rather than simply recognize information?

- Embed retrieval opportunities throughout instruction
- Gather evidence over time rather than relying solely on end-of-unit assessments

How the Science of Learning Strengthens Stage 2

Uses Retrieval-Based Evidence



Learning is strengthened when students retrieve information from memory

Assessment becomes a learning event, not just a measurement event

Frequent retrieval provides more accurate evidence of understanding

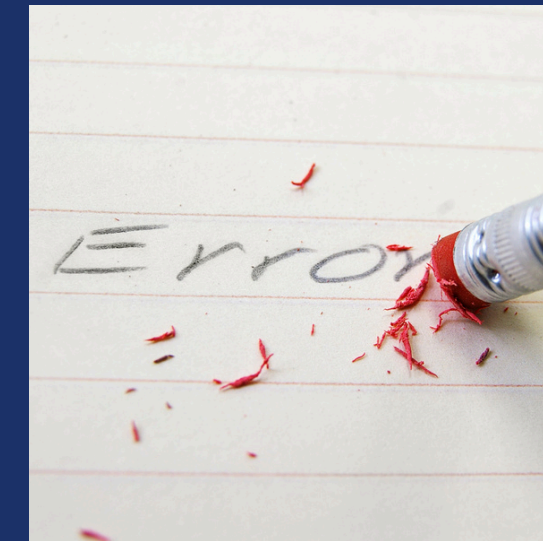
Stage 3

Planning Learning Experiences and Instruction

Are learning experiences designed around how memory and learning actually work?

- Build review into unit plans
- Use retrieval before re-teaching
- Sequence learning intentionally
- Design for long-term retention, not short-term performance

How the Science of Learning Strengthens Stage 3



Avoid “one and done” instruction and revisit important content over time.



Frequent opportunities to recall prior learning and help students correct misconceptions



Manage the amount of information students process at one time and support learning with scaffolds and worked examples

Science of Learning **IN THE CLASSROOM**

Categories to consider:

Today's focus:

- Learning (cognitive strategies)

Other areas:

- Thinking about learning (metacognition)
- Organizing learning
- Time management



STRATEGY: RETRIEVAL PRACTICE

This is a powerful, evidence-based learning strategy that involves actively recalling information from memory, rather than passively re-reading or reviewing it.

RETRIEVAL > RECOGNITION

Put it into Practice

Instead of: "Reread the chapter on the water cycle."



Try: "Without looking at your materials, draw and label the stages of the water cycle."

Instead of: "Look over the causes of the American Revolution."



Try: "List three causes of the American Revolution and explain each one without using your notes."

Instead of: "Read through the math examples again."



Try: "Solve a problem from memory before checking your notes or worked examples."

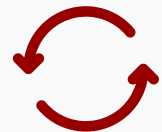
STRATEGY: SPACING

Spacing is strategically revisiting important content after some forgetting has occurred.



Instead of: One unit test and move on.

It is: Revisiting concepts over weeks and months.



Instead of: Practice multiplication facts or academic vocabulary for 30 minutes on Fridays.

It is: Practice multiplication facts or academic vocabulary for 5 minutes every few days over the next several weeks and months.



Instead of: Teach text structures in September and never revisit them.

It is: Include quick text structure review activities throughout the year.



STRATEGY: INTERLEAVING

After students have learned a skill, mix ***related*** topics or problem types so they must choose the appropriate strategy.

Instead of: 20 identical problems or various sets of problems grouped together.



Use: Mixed problem types requiring students to choose strategies.

Instead of: Practice only comma rules in today's lesson



Use: Edit a passage containing multiple grammar and punctuation skills.

Instead of: Complete one type of science graph over and over.



Use: Interpret different graph types and decide which skills to apply.



EXTRAS: THINKING ABOUT LEARNING (METACOGNITION)

What is Metacognition?

Metacognition is thinking about thinking. Students think about their own thinking to plan, monitor, and evaluate their learning.

We should have students reflect on what they know, what they don't know, and what strategies best help them learn.



Why it matters

- Builds self-awareness
- Improves self-regulation
- Helps students become independent learners

Prompts can include:

Exit Tickets, KWL, 3-2-1

- What concept do I understand well?
- What am I still confused about?
- What strategy will I use to improve?

It complements retrieval practice and spacing by encouraging students to choose effective study strategies rather than relying on intuition



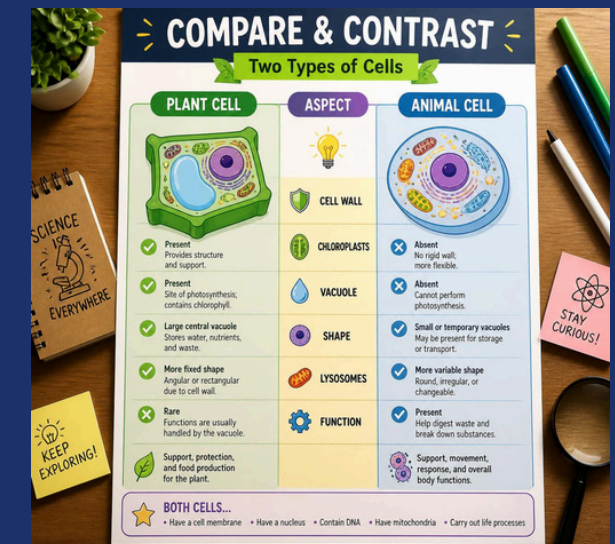
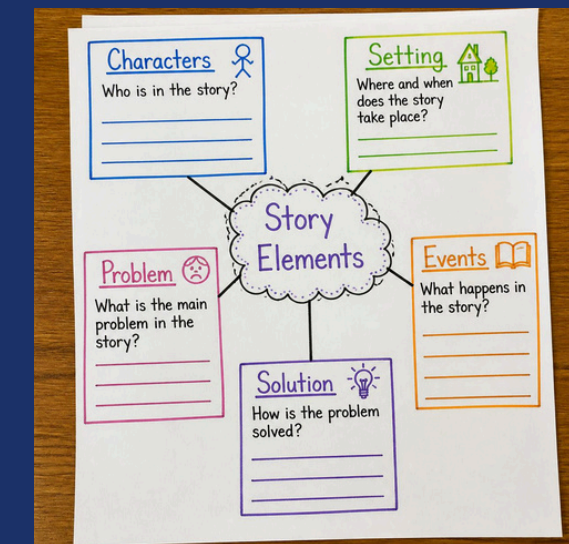
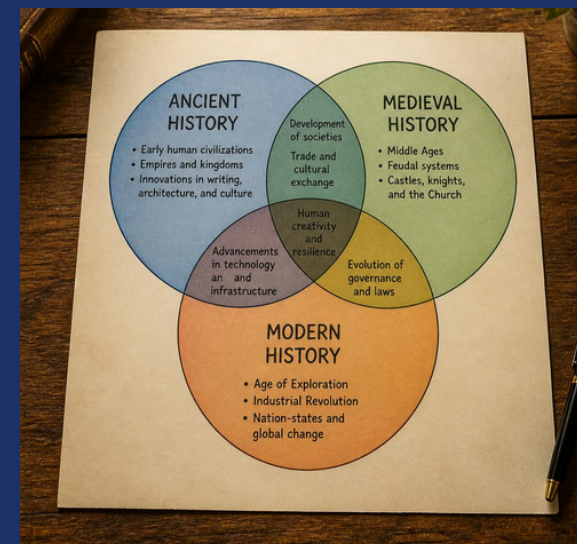
Organizing Learning

What is it?

Helping students organize information into meaningful patterns and connections.

Why it matters

- Reduces cognitive load
- Improves understanding
- Makes learning easier to remember



Strategy 1
Graphic Organizers
like Venn diagrams



Strategy 2
Concept maps or
Cluster maps



Strategy 3
Compare and
Contrast charts

Good Time Management



What is it?

Helping students plan, prioritize, and pace their learning over time.



Why it matters

- Reduces procrastination
- Supports consistent practice
- Encourages self-regulation



Simple strategies

- Break large tasks into smaller steps
- Set interim deadlines
- Use calendars or checklists
- Schedule short, regular study sessions



		Jan	Feb
Project A	Activity 1		
	Activity 2		
	Activity 3		
Project B	Activity 1		
	Activity 2		
	Activity 3		
Project C	Activity 1		
	Activity 2		
	Activity 3		

Takeaways

The Science of Learning utilizes many evidence-based practices.

Retrieval practice, spacing, and interleaving are three of the most powerful instructional strategies, but they're even more effective when combined with metacognition, organization, and good time management.



SCIENCE OF LEARNING

IS NOT THIS

Constant Kahoots or Quizizz without a retrieval purpose

Activities that are fun but require little thinking

Engagement for engagement's sake

Re-reading notes repeatedly

Highlighting everything

Excessive choices that overwhelm students

Slides overloaded with graphics, animations, and text



INSTEAD ...

Use quizzes as retrieval practice to strengthen memory

Design tasks that require students to explain, justify, or apply learning

Engagement that supports meaningful thinking

Retrieval practice from memory

Organizing, summarizing, and self-testing

Intentional choices with clear learning goals

Clean visuals that reduce cognitive load

Looking Busy $\neq$ Learning

The Hallmarks of Effective Learning



What We Should See Students Doing ...

- Retrieve information from memory
- Explain their thinking
- Apply learning in new situations
- Practice deliberately with feedback
- Revisit important ideas over time
- Discuss misconceptions and refine understanding
- Focus on the most important concepts



Examples

Theme Tracker

Use this chart to track evidence of the different themes as you read. Remember, the themes we are tracking include: HONOR, FRIENDSHIP, AMBITION, PERSUASION, PUBLIC vs. PRIVATE

ACT/SCENE:			
WHO	Said WHAT	WHICH theme	WHY is it evidence

Retrieval Practice

Example 1

Incorporate retrieval practice into English Language Arts instruction by requiring students to regularly recall and apply previously learned skills while reading literature.

For example, students could use a theme tracker graphic organizer to repeatedly identify evidence and analyze how a theme develops within a text or across multiple literary works.



Retrieval Practice

Example 2

In Math, incorporate retrieval practice by having students revisit and apply previously learned concepts through an ongoing storyline in which they solve a series of interconnected mathematical problems. Each new challenge should require students to recall and use skills from earlier lessons alongside newly learned content.



The Final Rinse

Valdo is almost ready to open his eco-friendly car wash in TurboTown. To make sure he doesn't blow a fuse over budgeting, he wants to figure out how much it will cost to operate for one full day. Here's what he knows:

- Each car wash uses 3 gallons of water and 2 ounces of soap.
- Water costs \$0.05 per gallon.
- Soap costs \$0.10 per ounce.

He expects to wash x cars in a day.

Help Valdo write an algebraic expression to represent the total cost for water and soap in one day. Then, use your expression to calculate how much it would cost if he washes 25 cars in one day.

Solution

Step 1: Write an expression for one wash

- Water cost per wash: $3 \text{ gallons} \times \$0.05 = \$0.15$
- Soap cost per wash: $2 \text{ ounces} \times \$0.10 = \$0.20$
- Total cost per wash: $\$0.15 + \$0.20 = \$0.35$

Step 2: Multiply by the number of cars

Let x represent the number of cars.

Expression:

$$\text{Total daily cost} = 0.35x$$

Step 3: Plug in $x = 25$

$$\text{Total Cost} = \$0.35 \times 25 = \$8.75$$

Valdo should expect to spend \$0.35 per car, or \$8.75 total to wash 25 cars in one day.



Retrieval Practice

Example 3

In all courses, retrieval practice can be incorporated through a variety of activities, including multiple-choice questions, short-answer responses, and graphic organizers. This Social Studies course follows that approach by using the ACE (Answer, Cite, Explain) method, which requires students to regularly retrieve information from memory, support their responses with evidence, and explain their reasoning. This repeated recall and application of prior learning helps strengthen retention and deepen understanding of key historical concepts and events.

Use retrieval practice to recall how to respond to APUSH Short Answer Questions (SAQs). Answer the questions from memory.

Tag and drop the explanations of each of the following ACE methods into the correct category.

A = Answer the Prompt	C = Cite Specific Evidence	E = Explain Why It Matters	Choices
			Weak Example: Jamestown was founded for economic reasons.
			Restate the question in your answer. Make clear, direct historic claim. Do NOT be vague.
			Strong Example: The Virginia Company funded Jamestown in 1607 hoping to find gold and establish profitable trade.
			Ask yourself: Did I include something specific? Could this be verified in a textbook?
			Ask yourself: Did I explain how my evidence proves my claim? Did I connect it to a larger theme?
			Show how your evidence proves your answer. Explain cause and effect, or significance. Use phrases like: "This led to..." "As a result..." "This demonstrates..."

Prompt: Briefly explain one economic reason for the founding of Jamestown. BEST follows the ACE method?

- ☐ Jamestown was founded to make money for England by finding gold and establishing profitable trade.
- ☐ Jamestown was founded for economic reasons because the colonists were looking for gold and silver.
- ☐ The colonists were looking for gold and silver.
- ☐ One economic reason for the founding of Jamestown was the Virginia Company's goal of finding gold, which would increase wealth for investors.

Prompt: Briefly explain one challenge faced by Jamestown. full credit using ACE?

- ☐ One major challenge was the lack of food.
- ☐ Jamestown struggled because of the harsh winter.
- ☐ One challenge Jamestown faced was the lack of food. Because many settlers were not used to the harsh winter.

Retrieval Practice

Example 4

In Science, retrieval practice can be incorporated through the use of case studies that require students to recall and apply previously learned concepts to real-world scenarios. As students analyze data, evaluate evidence, and explain scientific phenomena, they repeatedly retrieve information from memory and connect new learning to prior knowledge. This process strengthens long-term retention while helping students develop deeper conceptual understanding and scientific reasoning skills.

The screenshot shows a lesson page from Virtual Arkansas. The header includes the Virtual Arkansas logo and the tagline "EQUIP. ENGAGE. EMPOWER." The main title is "5.1 Acid Base Theories" and the subtitle is "Retrieval Practice". A navigation sidebar on the left lists various topics, with "Retrieval Practice" highlighted. The main content area features a case study titled "Case Study: Checking a Medication Dose" with a green checkmark icon. The text of the case study reads: "It's time to put your stoichiometry skills back into action! Using what you learned in our Stoichiometry unit (balanced equations, mole ratios, and dimensional analysis), complete Show all necessary work and include proper units. In chemistry, the moles demand respect, and answers without work When you finish, upload your completed assignment for grading. (15 pts)". Below the text is a table with four columns: "Background", "The Problem", "Student Tasks", and "Reflection". The "Background" column contains the text: "BACKGROUND You are a pharmacy technician working in a hospital pharmacy. While checking an IV medication preparation, you notice that the dose written on the preparation label seems incor". Below the table is a section titled "PATIENT INFORMATION" with the following details: "Name: Patient W.M.", "Weight: 70.0 kg", and "Diagnosis: Receiving IV chemotherapy support". At the bottom of the page, there is a "Practice" button and a copyright notice: "Copyright 2020, Idaho Digital Learning Alliance".

Skip to main content

Navigation

- Lesson Overview
- Arrhenius Acids and Bases
- Lewis Acids and Bases
- Naming Rules
- Formation of Acids
- Neutralization Reaction
- Bronsted-Lowry Acids and Bases
- Bronsted-Lowry Contd.
- Watch
- Chemistry is Everywhere
- Practice
- Retrieval Practice**
- Closing the Lesson

Virtual Arkansas
EQUIP. ENGAGE. EMPOWER.

5.1 Acid Base Theories

Retrieval Practice

Case Study: Checking a Medication Dose

It's time to put your stoichiometry skills back into action!

Using what you learned in our Stoichiometry unit (balanced equations, mole ratios, and dimensional analysis), complete Show all necessary work and include proper units. In chemistry, the moles demand respect, and answers without work When you finish, upload your completed assignment for grading.

(15 pts)

Background	The Problem	Student Tasks	Reflection
BACKGROUND You are a pharmacy technician working in a hospital pharmacy. While checking an IV medication preparation, you notice that the dose written on the preparation label seems incor			

PATIENT INFORMATION

Name: Patient W.M.
Weight: 70.0 kg
Diagnosis: Receiving IV chemotherapy support

Practice

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Teaching and Learning

The measure of great instruction is not just what we teach, it's what students can still retrieve, explain, and apply weeks, months, and years later.



Small Changes | Big Impact



You don't have to redesign your classroom. Start by adding just one evidence-based practice.

- ✓ One retrieval activity
- ✓ One spaced review
- ✓ One interleaved assignment

Small instructional changes can produce lasting improvements in learning.

Thank You!

Questions? Contact us:



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