

Brain-based Research: BEST PRACTICES IN TEACHING

Learning is the acquisition of knowledge and skills and it requires memory so that our knowledge and skills are available to us when we need them.

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PART 2

SMART PRACTICE

*“It is not that I’m so smart.
But I stay with the questions much longer.”*

— Albert Einstein

Over a hundred years ago the German psychologist Hermann Ebbinghaus determined that we humans forget 90% of what is taught in class within 30 days (1885). Most of this forgetting occurs just hours after being exposed to the new material.

When we encounter new information, neurons in our brain activate, but the stimulation lasts only up to 90 minutes unless it is reactivated (Squire, Kandel, 1999). We begin to commit the new learning to memory when we first practice it, but for learning to endure in our memory, we must return to it at intervals and in different ways over weeks, months, and even years.

This series of articles explains recent research in memory and learning and describes two kinds of applications to enhance our classroom practices: Enriched Learning and Smart Practice.

RIGHT: SPACED REPETITION

A popular model in education is “teaching to mastery.” We often interpret this to mean that students need to practice a language point intensely until it is burned into memory. Indeed, while students are practicing, they demonstrate an easy fluency with the material. That is because it is active in their working memory. Teachers and students alike prefer this intensive kind practice (also known as massed practice) because it produces rapid, if ephemeral, gains. Quickly students gain confidence in their control of the material. It feels familiar and known. If tested immediately after intensive repetition and in a way that simulates the rehearsal, students score well.

It turns out, however, that intensive repetitive practice leads to quick learning AND quick forgetting. (Dunlosky, 2013). If students are tested on that same material just a day later, their scores drop precipitously. The challenge is to have students put the material aside—in other words, store it—and then return to it. The test is whether students can access the information they stored. In terms of how much information we can store, there is no limit. It is merely a problem of retrieving the information when we need it.

Spacing student practice over time has proven to be more effective than intensive practice (Cepada 2003.) Indeed, even if students spend the same amount of time in their practice, students who practice at intervals retain their knowledge and skills for a longer period than those who practice it intensely all at once (Dunlosky 2013). This means one hour of intensive practice is less valuable than four intervals of 15 minutes each. Ideally the intervals should occur at longer and longer lag times over the ensuing days, weeks, and months. Between each interval, students begin forgetting the information. Then, when students make an effort to retrieve that information, they strengthen their retrieval. The students are building a memory pathway to the information.

Classroom Applications

Encourage students to develop a system for distributing their study time throughout the week.

Study Calendars

- Hand out weekly calendars or have students use their cell-phone calendars.
- On the first class of the week, ask students to schedule **at least four times** they will study English outside of class.

Data Speaks

- At the start of each week, ask students to look at their calendar and to count the number of times they studied English outside of class the previous week.
- Then test student retention of the material presented and practiced in the previous week. To test, you can use a section of your textbook's unit test, or a simple dictation of questions or prompts to which students write responses.
- At the top of the test, have students write the number of times they studied the previous week. Quickly, students will recognize the relationship between studying at intervals and their retention of knowledge and skills.

MIX IT UP: INTERLEAVED REPETITION

From the research discussed above, we know that intensive practice on one learning point is less effective than spacing out the intervals of practice. What happens if we focus on something different between intervals? What happens if we mix up the curriculum so that it spirals rather than moves in a linear progression?

At Washington University in Missouri, researchers tested that question. They introduced students to multiple works of 12 artists. In Group A they exposed the subjects to multiple examples of work by one artist before introducing multiple works by another artist. In Group B the researchers interleaved the material so students were introduced to a mixed sequence of paintings and artists. They were introduced to one artist and one painting followed by a different artist and a different painting. Then both Groups A and B were tested on their ability to identify the artists of the paintings. Group B consistently outperformed Group A (Kornell, Castel, Eich, Bjork 2010). Furthermore, Group B students were more effective at identifying the artists of works, hitherto unseen. These results have been repeated in multiple other studies. (Brown 2014. Dunlosky 2014.)

Various principles in learning explain the effectiveness of interleaving. In massed practice, students retrieve information once and then practice it in their working memory. They may strengthen their information but not their ability to retrieve it. By interleaving and alternating learning points, students are forced to forget and remember information repeatedly. Also, by focusing on differences rather than commonalities, interleaving develops stronger discriminating skills. This in turn strengthens students' ability to transfer their knowledge to new settings.

Classroom Applications

Try to interleave your material so that your curriculum moves not in a line but rather in a spiral.

Contrast New with Old

Insert previous practice material into your current lessons. Align the material so that it contrasts to a current learning point. For example:

- **Grammar:** If your students are practicing simple past verb forms, insert a few practice examples of the *simple present* practice as well.
- **Vocabulary:** If students are reviewing vocabulary from your housing unit, insert a few vocabulary items from the previous health unit as well.
- **Pronunciation:** If students are practicing the pronunciation of simple-past end sounds (*d/t/id*), have them also pronounce a few verbs in the simple present third-person singular form. This will heighten their awareness of the final ending of a verb.
- **Listening:** Have students listen to a previous dialogue that contains an example of the current language point.

Ask students to identify the language point in the dialogue.

Conversation Cards

- At the end of every class, write any questions you practiced that day on cards—one question per card. These questions may be from practice conversations, worksheets, or discussions.
- At the beginning of the following class, have pairs of students take turns picking up a card and asking their partner the question.
- Randomly recycle the cards over the course of your semester.

Vocabulary Flashcards

Have students make a flashcard of each new vocabulary item in class. Between class activities, have pairs of students quiz their partners on their flashcards. Prompt them with one of these questions:

- How do you spell _____?
- How do you say _____? (shows word)
- What does _____ mean?
- Make a sentence with _____.
- Look at the word. Is it a noun, verb, or adjective?
- Look at the word. How many syllables does it have? Which syllable is stressed?

LET THE STUDENTS SPEAK: TESTING IN A NEW LIGHT

Memory has two dimensions: storage and retrieval. Often as educators, we emphasize the storage aspect of memory. We present material and require students to practice it in multiple ways. Less often, we ask students to retrieve what they learned, that is until we administer a final test. Students need to practice retrieving the information early on, and at intervals throughout their learning. They need to create a path in their memory so they can find the information when they need it.

One of the most effective ways to practice that retrieval is to test students, or, to cast testing in a different light, to give students an opportunity to recall their learning. In one study, after the introduction of new material, Group A was asked to recall their learning without notes or prompts; Group B spent the same amount of time studying the material and reviewing notes. Two days later both groups were tested. Group A performed better. A

week later both groups were retested. Group A forgot only 10%, whereas Group B forgot 52% of the material. The recall-test improved the durability of memory of Group A. (Roediger and Karpicke, 2006) These results have been repeated in many other studies.

Research also places some caveats for testing. Fear of negative evaluation can reduce students' capacity for learning (Langer, 1995. Brown 2014). It is important to present tests to students as a way for them check their learning, not as a way for you to evaluate them. If you administer tests often and show students that it is a tool for learning, you are more likely to get the benefits of the retrieval practice without the dangers of anxiety and discouragement.

Studies also show that tests that simply require a student to supply an answer (open recall) rather than recognize a correct item (multiple choice and true/false) are more effective in strengthening student recall (Brown 2014).

Classroom Applications

Tests do not have to be intimidating or a lot of extra work for you. Here are some ideas for easy class testing.

Vocabulary Reviews

- Dictate several words from recent classes.
- Tell students to define the words.
- Review student answers orally.

Reconstruct a Story (To test listening comprehension, grammar, vocabulary, and spelling.)

- Students put pencils down.
- Tell a simple story that uses the grammar point you taught in class. Tell the story several times, asking questions along the way so you know students understand the basic story line.
- Have students reconstruct the story in writing.
- Have students hand in their papers.
- Provide written corrective feedback on their grammar form and usage.

Open-Ended Grammar Response

- Dictate a discussion question from the textbook lesson. (Often a lesson will provide an interesting discussion question at the beginning or end of a lesson.)
- Tell students to write their responses using the new grammar.
- Have students hand in their papers.
- Provide written corrective feedback.

Total Recall

- Erase the board. Have students put away their notes.
- Give students 3 minutes to write down what they learned in class. This could be a list of words or full sentences.
- In pairs have students explain their learning to a partner.

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