Effective Revision and Study Tips for Students
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Learning Tips for Students from *Make It Stick: The Science of Successful Learning*

Remember that the most successful students are those who take charge of their own learning and follow a simple but disciplined strategy. You may not have been taught how to do this, but you can do it, and you will likely surprise yourself with the results.

**Embrace the fact that significant learning is often, or even usually, somewhat difficult.** You will experience setbacks. These are signs of effort, not of failure. Setbacks come with striving, and striving builds expertise. **Effortful learning changes your brain, making new connections, building mental models, increasing your capability.** The implication of this is powerful: Your intellectual abilities lie to a large degree within your own control. Knowing that this is so makes the difficulties worth tackling.

Following are **three key study strategies.** Make a **habit** of them and structure your time so as to pursue them with regularity.

**1. Practice Retrieving New Learning from Memory**

*What does this mean?* "Retrieval practice" means self-quizzing. Retrieving knowledge and skill from memory should become **your main study strategy in place of rereading.**

*How to use retrieval practice as a study strategy:* When you read a text or study class notes, pause periodically (every so often) to ask yourself questions like these, **without looking** in the text: What are the key ideas? What terms or ideas are new to me? How would I define them? How do the ideas relate to what I already know?

Many textbooks have study questions at the ends of the chapters, and these are useful for self-quizzing. Generating questions for yourself and writing down the answers is also a good way to study.

Set aside a little time every week throughout the term to quiz yourself on the material in a course, both the current week's work and material covered in prior weeks.

When you quiz yourself, check your answers to make sure that your judgments of what you know and don't know are accurate.

Use quizzing to identify areas of weak knowledge or understanding, and focus your studying to make them strong.

The harder it is for you to recall new learning from memory, the greater the benefit of doing so. Making errors will not set you back, so long as you check your answers and correct your mistakes.

*What your intuition tells you to do:* Most students focus on underlining and
highlighting text and class notes and PowerPoint slides. They dedicate their time to rereading these, becoming fluent in the text and terminology, because this feels like learning.

**Why retrieval practice is better:** After one or two reviews of a text, self-quizzing is far more potent for learning than additional rereading. Why might this be so? This is explained more fully in Chapter 2, but here are some of the high points.

The familiarity with a text that is gained from rereading creates illusions of knowing, but these are not reliable indicators of mastery of the material. Fluency with a text has two strikes against it: it is a misleading indicator of what you have learned, and it creates the false impression that you will remember the material.

By contrast, quizzing yourself on the main ideas and the meanings behind the terms helps you to focus on the central concepts rather than on peripheral material or on a teacher’s turn of phrase. Quizzing provides a reliable measure of what you’ve learned and what you haven’t yet mastered. Moreover, quizzing slows down forgetting. Forgetting is human nature, but practice at recalling new learning secures it in memory and helps you recall it in the future.

Periodically practicing new knowledge and skills through self-quizzing strengthens your learning of it and your ability to connect it to prior knowledge.

A habit of regular retrieval practice throughout the duration of a course puts an end to cramming and late nights. You will need little studying at exam time. Reviewing the material the night before is much easier than learning it.

**How it feels:** Compared to rereading, self-quizzing can feel awkward and frustrating, especially when the new learning is hard to recall. It does not feel as productive as rereading your class notes and highlighted passages of text feels. But what you don’t sense when you’re struggling to retrieve new learning is the fact that every time you work hard to recall a memory, you actually strengthen it. If you restudy something after failing to recall it, you actually learn it better than if you had not tried to recall it. The effort of retrieving knowledge or skills strengthens its staying power and your ability to recall it in the future.

**2. Space Out Your Retrieval Practice**

**What does this mean?** Spaced practice means studying information more than once but leaving considerable time between practice sessions.

**How to use spaced practice as a study strategy:** Establish a schedule of self-quizzing that allows time to elapse between study sessions. How much time? It depends on the material. If you are learning a set of names and faces, you will need to review them within a few minutes of your first encounter, because these associations are forgotten quickly. New material in a text may need to be revisited within a day or so of your first encounter with it. Then, perhaps not again for several days or a week. When you are feeling more sure of your mastery of certain material, quiz yourself on it once a month. Over the course of a term, as you quiz yourself on new material, also reach back to retrieve prior material and ask yourself how that knowledge relates to what you have subsequently learned.
If you use flashcards, don't stop quizzing yourself on the cards that you answer correctly a couple of times. Continue to shuffle them into the deck until they're well mastered. Only then set them aside—but in a pile that you revisit periodically, perhaps monthly. **Anything you want to remember must be periodically recalled from memory.**

Another way of spacing retrieval practice is to interleave the study of two or more topics, so that alternating between them requires that you continually refresh your mind on each topic as you return to it.

**What your intuition tells you to do:** Intuition persuades us to dedicate stretches of time to single-minded, repetitive practice of something we want to master, the massed "practice-practice-practice" regime we have been led to believe is essential for building mastery of a skill or learning new knowledge. These intuitions are compelling and hard to distrust for two reasons. **First, as we practice a thing over and over we often see our performance improving, which serves as a powerful reinforcement of this strategy. Second, we fail to see that the gains made during single-minded repetitive practice come from short-term memory and quickly fade. Our failure to perceive how quickly the gains fade leaves us with the impression that massed practice is productive.**

Moreover, most students, given their misplaced faith in massed practice, put off review until exam time nears, and then they bury themselves in the material, going over and over it, trying to burn it into memory.

**Why spaced practice is better:** It's a common but mistaken belief that you can burn something into memory through sheer repetition. Lots of practice works, but only if it's spaced.

If you use self-quizzing as your main study strategy and space out your study sessions so that a little forgetting has happened since your last practice, you will have to work harder to reconstruct what you already studied. In effect, you're "reloading" it from long-term memory. This effort to reconstruct the learning makes the important ideas more memorable and connects them more securely to other knowledge and to more recent learning. It's a powerful learning strategy.

**How it feels:** Massed practice feels more productive than spaced practice, but it is not. Spaced practice feels more difficult, because you have gotten a little rusty and the material is harder to recall. It feels like you're not really getting on top of it, whereas in fact, quite the opposite is happening: As you reconstruct learning from long-term memory, as awkward as it feels, you are strengthening your mastery as well as the memory.

3. **Interleave the Study of Different Problem Types**

**What does this mean?** If you're trying to learn mathematical formulas, study more than one type at a time, so that you are alternating between different problems that call for different solutions. If you are studying biology specimens, Dutch painters, or the principles of macroeconomics, mix up the examples.
How to use interleaved practice as a study strategy: Many textbooks are structured in study blocks: They present the solution to a particular kind of problem, say, working out the volume of a spheroid, and supply many examples to solve before moving to another kind of problem (working out the volume of a cone). Blocked practice is not as effective as interleaved practice, so here's what to do.

When you structure your study timetable, once you reach the point where you understand a new problem type and its solution but your grasp of it is still basic, scatter this problem type throughout your practice sequence so that you are alternately quizzing yourself on various problem types and retrieving the appropriate solutions for each.

If you find yourself falling into single-minded, repetitive practice of a particular topic or skill, change it up: mix in the practice of other subjects, other skills, constantly challenging your ability to recognize the problem type and select the right solution.

What your intuition tells you to do: Most learners focus on many examples of one problem or question at a time, wanting to master the type before moving onto studying another topic.

Why interleaved practice is better: Mixing up problem types improves your ability to discriminate between types, identifying the unifying characteristics within a type, and improves your success in a later exam or in real-world settings, where you must work out the kind of problem you're trying to solve in order to apply the correct solution. (This is explained more fully in Chapter 3.)

How it feels: Blocked practice—that is, mastering all of one type of problem before progressing to practice another type—feels (and looks) like you're getting better mastery as you go, whereas interrupting the study of one type to practice a different type feels disruptive and counterproductive. Even when learners achieve better mastery from interleaved practice, they persist in feeling that blocked practice serves them better. You may also experience this feeling, but you now have the advantage of knowing that studies show that this feeling is an illusion.

Other Effective Study Strategies

ELABORATION improves your mastery of new material and multiplies the mental cues available to you for later recall and application of it (Chapter 4).

What is it? Elaboration is the process of finding additional layers of meaning in new material.

For instance: Examples include relating the material to what you already know, explaining it to somebody else in your own words, or explaining how it relates to your life outside of class.

A powerful form of elaboration is to discover a metaphor or visual image for the new material. For example, to better grasp the principles of angular momentum in physics, visualize how a figure skater's rotation speeds up as her arms are drawn
into her body. When you study the principles of heat transfer, you may understand conduction better if you imagine warming your hands around a hot cup of chocolate. When you learned about the structure of an atom, your physics teacher may have used the analogy of the solar system with the sun as the nucleus and electrons spinning around like planets. The more that you can elaborate on how new learning relates to what you already know, the stronger your grasp of the new learning will be, and the more connections you create to remember it later.

**REFLECTION** is a combination of retrieval practice and elaboration that adds layers to learning and strengthens skills.

**What is it?** Reflection is the act of taking a few minutes to review what has been learned in a recent class and asking yourself questions. What went well? What could have gone better? What other knowledge or experience does it remind you of? What might you need to learn for better mastery, or what strategies might you use the next time to get better results?

**CALIBRATION** is the act of aligning your judgments of what you know and don’t know with objective feedback so as to avoid being carried off by the illusions of mastery that catch many learners by surprise at test time.

**What is it?** Everyone is subject to cognitive illusions, some of which are described in Chapter 5. Mistaking fluency with a text for mastery of the underlying content is just one example. Calibration is simply the act of using an objective instrument to clear away illusions and adjust your judgment to better reflect reality. The aim is to be sure that your sense of what you know and can do is accurate.

**For instance:** Students use quizzes and practice tests to see whether they know as much as they think they do. It’s worth being explicit here about the importance of answering the questions in the quizzes that you give yourself. **Too often we will look at a question on a practice test and say to ourselves: Yup, I know that,** and then move down the page without making the effort to write in the answer. If you don’t supply the answer you may be giving in to the illusion of knowing when in fact you would have difficulty giving an accurate or complete response. **Treat practice tests as tests, check your answers, and focus your studying effort on the areas where you are not up to scratch.**

**MNEMONIC DEVICES** help you to retrieve what you have learned and to hold arbitrary information in memory (Chapter 7).

**What are they?** "Mnemonic" is from the Greek word for memory, and mnemonic devices are like mental file cabinets. They give you handy ways to store information and find it again when you need it. Mnemonics are not tools for learning per se but for creating mental structures that make it easier to retrieve what you have learned.
LEARN TO STUDY USING...

Retrieval Practice

HOW TO DO IT

Put away your class materials, and write or sketch everything you know. Be as thorough as possible. Then, check your class materials for accuracy and important points you missed.

Take as many practice tests as you can get your hands on. If you don’t have ready-made tests, try making your own and trading with a friend who has done the same.

You can also make flashcards. Just make sure you practice recalling the information on them, and go beyond definitions by thinking of links between ideas.

HOLD ON!

Retrieval practice works best when you go back to check your class materials for accuracy afterward.

Retrieval is hard! If you’re struggling, identify the things you’ve missed from your class materials, and work your way up to recalling it on your own with the class materials closed.

Don’t only recall words and definitions. Make sure to recall main ideas, how things are related or different from one another, and new examples.

RESEARCH

Read more about retrieval practice as a study strategy

LEARN TO STUDY USING...
Spaced Practice
SPACE OUT YOUR STUDYING OVER TIME

LEARNINGSIENTISTS.ORG

HOW TO DO IT

Start planning early for exams, and set aside a little bit of time every day. Five hours spread out over two weeks is better than the same five hours all at once.

Review information from each class, but not immediately after class.

After you review information from the most recent class, make sure to go back and study important older information to keep it fresh.

HOLD ON!

When you sit down to study, make sure you are using effective study strategies rather than just re-reading your class notes.

This may seem difficult and you may forget some information from day to day, but this is actually a good thing! This forces you to retrieve information from memory (see Retrieval Practice poster).

Create small spaces (a few days) and do a little bit over time, so that it adds up!

RESEARCH

Read more about spaced practice as a study strategy


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LEARN TO STUDY USING...

Interleaving
SWITCH BETWEEN IDEAS WHILE YOU STUDY

HOW TO DO IT

Switch between ideas during a study session. Don’t study one idea for too long.

Go back over the ideas again in different orders to strengthen your understanding.

Make links between different ideas as you switch between them.

HOLD ON!

While it’s good to switch between ideas, don’t switch too often, or spend too little time on any one idea; you need to make sure you understand them.

Interleaving will feel harder than studying the same thing for a long time. But don’t worry - this is actually helpful to your learning!

RESEARCH


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LEARN TO STUDY USING...
Dual Coding
COMBINE WORDS AND VISUALS

HOW TO DO IT

Look at your class materials and find visuals. Look over the visuals and compare to the words.

Look at visuals, and explain in your own words what they mean.

Take information that you are trying to learn, and draw visuals to go along with it.

HOLD ON!

Try to come up with different ways to represent the information visually, for example an infographic, a timeline, a cartoon strip, or a diagram of parts that work together.

Work your way up to drawing what you know from memory.

RESEARCH

Read more about dual coding as a study strategy


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LEARN TO STUDY USING...
Concrete Examples
USE SPECIFIC EXAMPLES TO UNDERSTAND ABSTRACT IDEAS

HOW TO DO IT

Collect examples your teacher has used, and look in your class materials for as many examples as you can find.

Make the link between the idea you are studying and each example, so that you understand how the example applies to the idea.

Share examples with friends, and explain them to each other for added benefits.

HOLD ON!

You may find examples on the internet that are not used appropriately. Make sure your examples are correct - check with your teacher.

Ultimately, creating your own relevant examples will be the most helpful for learning.

RESEARCH

Read more about concrete examples as a study strategy

LEARN TO STUDY USING...

Elaboration
EXPLAIN AND DESCRIBE IDEAS WITH MANY DETAILS

HOW TO DO IT

Ask yourself questions while you are studying about how things work and why, and then find the answers in your class materials and discuss them with your classmates.

As you elaborate, make connections between different ideas to explain how they work together. Take two ideas and think of ways they are similar and different.

Describe how the ideas you are studying apply to your own experiences or memories. As you go through your day, make connections to the ideas you are learning in class.

HOLD ON!

Make sure the way you are explaining and describing an idea is accurate. Don’t overextend the elaborations, and always check your class materials or ask your teacher.

Work your way up so that you can describe and explain without looking at your class materials.

RESEARCH

Read more about elaboration as a study strategy
