Wisdom World

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6.7 How to Study, Pass Exams (draft)

Contents

The target populations of this article are **high school and college students**. This is not a comprehensive step-by-step manual on the Contents material above, because most of that is familiar to most students. Here we discuss key concepts often missed by students that might significantly improve their success rates.

It is unbelievable that schools and universities are centers of learning, yet they do not offer courses on how to study and take exams (!), although this subject is often covered in psychology courses. There are a few internet sites on how to study and take exams but they are inadequate because they only cover the obvious, such as do not procrastinate, finish your homework first, don't cram at the last minute, etc., usually without even explaining why. The explanations are essential because they tell you if they really work, and are needed for the students to figure out when/how to use them. So here are my ideas, developed through my education experience from first grade to final PhD exam in Physics at Cornell University.

(1) Objectives of learning how to study: The reasons for learning how to study are (1) to accelerate the learning process in order to have more time left for other activities and (2) to help pass exams and (3) to get the maximum benefit from the learning. The brain automatically processes all information entering it, often in ways that we are unaware of; therefore, knowing the way the brain functions is the key to designing efficient learning methods, such as how to solve difficult homework assignment problems.

Understanding the text book (or teaching material) is the most important step in any study. Students often try to memorize lessons in textbooks, but that is a mistake because memorizing requires more work than understanding **in the long run**, and material you understand are more useful than material you memorized. Understanding is better because if you memorize, you can forget it but if you understand the material you will never forget it. **Learning is basically a memory process;** therefore we must study:

(2) Memorizing, because understanding is a subcategory of memorizing. A memory in the

brain is a bunch of memory locations distributed within the brain, called a **memory field**. When we memorize, storing the information is not a problem because it is automatic and basically permanent — the brain automatically and permanently stores every experience; however, *recalling the memory* is a problem because, unlike a computer in which all data have addresses, human memory is retrieved by a complex process that is not yet sufficiently understood.

Memory is associative. The best hypothesis today about how humans memorize is that the memory recall process is an **association** process, and the most obvious associative process is an overlap of **memory fields** (Scientific American, July 2017, P. 30). That is, when two related memories are stored, **their memory fields overlap**; the closer the relationship, the greater the overlap and the easier the recall. When one member of two overlapping memory fields "fires", it also fires the other over-lapping member. By following a series of such overlaps, the brain recalls a memory starting with a known memory. I wrote these ideas about memory fields and overlaps many years before that article appeared in Scientific American with photos of memory fields and their overlap!

The best support for the associative nature of human memory comes from tests on super memorizers who can perform "incredible" feats such as memorizing hundreds of telephone numbers from a phone book (incredible is in "--", because in reality, anyone can learn them), see:

https://www.academictips.org/memory/index.html Link #1

Good memorizers all use **associative algorithms** for memorizing. The algorithms are different for each person, but they are all devices for associating the objects to be memorized with something that have patterns that are already in memory.

For example, for remembering hundreds of numbers, one algorithm is to associate a sound with each number. The sounds are chosen such that they form "words" when strung together, not in English, but in a new "language" (algorithm) that is created for that purpose. Japanese is a language with such a property. For example, the square root of 2 is 1.41421356 which can be read as a phrase that translates roughly to, "good people, good people are worth looking at" (hitoyo-hitoyoni-hitomigoro – hito [1] yo [4] hito [1] yo [4] ni [2] hito [1] mi [3] go [5] ro [6]), and the Japanese routinely use such algorithms to remember such things as telephone numbers. To 7 decimals, the square root of 3 reads "Treat the entire world!" and the root of 5 reads "On the 6th station of Mt. Fuji, an owl is crying"; I learned these over 60 years ago and still remember them.

The amazing thing is the speed with which good memorizers can map the object to be memorized onto their algorithms. Super memorizers develop after much hard work in perfecting their algorithms and practicing diligently. This "hard work" comes effortlessly because they enjoy it. Thus these memorizers are not born geniuses as most people believe; their abilities come from hard work. One possible exception is savants, but nobody knows if they were born with memory abilities or were silently practicing without our knowledge.

Let's try one sample algorithm. Suppose that you want to memorize the sequence of 14 numbers 53031791389634. One way to do it is to use something like the following story: "I woke up at 5:30 AM with my 3 brothers and 1 grandmother; the ages of my brothers are 7, 9, and 13, and my grandma is 89

years old, and we went to bed at 6:34 PM." This is an algorithm based on life's experience, which makes the random numbers "meaningful". What is so intriguing is that the algorithm contains 132 letters, yet it is much easier to remember than the 14 numbers because of familiar associations. You can test this for yourself: first memorize both the 14 numbers (if you can -- it is not easy for me) and the above algorithm. Then next day, try to write down the numbers, first from memory and then from the algorithm; you will find the algorithm to be much better. Super memorizers use even better algorithms; see Link #1.

Memory is most easily recalled if it is associated with something easy to remember, such as outrageous, funny, familiar, etc., because the brain is attracted to them. This is the most common trick used by good memorizers. For example, if you are a Christian and want to remember John's name, you imagine him dunking you into as cold lake (John the baptist).

To become a good memorizer, you must develop your own algorithms (for difficult material such as a long list of numbers) or find appropriate associations (for a small number of items) as explained in Link #1; however, for things like multiplication tables that are used almost every day, you can simply memorize them without associations because the memory is reinforced every time it is used. Even if you do not make a conscious association, the brain creates a memory field overlap for anything you memorize; however, the retrieval process is not as reliable as one you make that has a logical or memorable association.

In a computer, memory is retrieved using addresses. There are no addresses in the brain; instead it follows the overlaps of related concepts until it arrives at the desired memory. That is, memory by itself is useless unless you can recall it, so when we say “memory”, we mean “memory with a recall mechanism”. For human brains, that recall mechanism is the overlap of memory fields, and to have overlap, you need another memory that is associated with it, which makes memory **associative**. It is easy to show mathematically that **the possible number of memory fields and associations is effectively infinite** for the human brain although the actual number of useful associations is much smaller; however, a fraction of an infinite number can still be infinite. The material of this section is the basis for the statement: **”The more you memorize, the more you can memorize”.** Every time you memorize, you will become a better memorizer! This explains why there is such a huge difference between good and bad memorizers, giving rise to the perception that good memorizers are especially gifted.

(3) U**nderstanding vs memorizing:** Understanding is a sub-category of associative memory. In understanding something, you start with a known (“simple”) concept in memory and provide a path of associations that uniquely leads to the item you want to understand. This is why you can't forget it – even if you do forget, you can always recall it by deriving it starting from the original known, simple, item.

Example: to understand **algebr**a, you simply have to know that it is based on the idea of giving an unknown a temporary name

unknown = x that's all!

You can't do anything with an unknown that you know nothing about, but by giving the unknown a name, you can put it into an equation, which gives rise to the concept of equations and enables you to start discovering all the things you can do with them. Solutions to equations can be simple numbers, but they can also be complex functions, giving rise to the concept of functions, etc.. This is how you understand the concept of functions.

Another example: **calculus** is based on the concept that any volume can be approximated by a sum of thin parallelepipeds; the thinner the parallelepipeds, the better the approximation. Since we know the formula for calculating the volume of parallelepipeds, this means that you can potentially calculate the volume of any shape. If the volume changes slightly, the change in volume is just the difference between the original and changed shapes and, combined with the concept of an equation from algebra, you get to the concept of differential equations. Functions and differential equations provide extremely powerful mathematical tools for solving numerous problems. Moreover, once you understand these concepts, it is nearly impossible to forget them.

Note in the above two examples that the basic concepts in algebra and calculus are trivially simple. Unfortunately, too many math lessons try to introduce complicated examples from these fields in the belief that students will understand the subject better if they can handle more complex cases. After all, math students are supposed to be bright, so why trifle with trivially simple stuff? I disagree with that concept; I believe that, to teach a subject, it should be simplified as much as possible in order to reveal the most basic principles on which the field is based. But this isn't as easy as it sounds; you need a true, in-depth understanding to figure out the most basic, simplest underlying principles. The result of having to tackle unnecessarily complex material is that even smart students get confused and frustrated whereas simple basic concepts are easy to understand, you never forget them, and give the students self confidence. Thus, the ability to reduce the essence of any field such as algebra to its simplest basic tenets is a key element in the process of understanding.

(4) Solving homework problems: Do your homework as soon as possible while the lessons just completed in class are still fresh in your mind; this process reinforces the lessons in the brain. If you wait till later when you have forgotten some, there will be less material to reinforce and parts of the lessons get lost. If you wait till the last minute, you are under a short deadline, you get stressed that you might not have enough time, and a stressed mind does not work as well. You end up spending more time than necessary to complete the work.

What do you do if you hit a difficult homework problem you can't solve? Here's a trick. Think hard about the problem, and review the course material, THEN FORGET THE WHOLE THING! **Humans have many brains, not just one.** One of them, which you might call the **subconscious brain**, operates independently of your conscious brain and tends to do its own thing. After you think hard about a problem, the subconscious will get the message that this matter is important and start thinking about it while you forget about the problem in the conscious brain – your brain is doing double duty! All of a sudden, out of nowhere, the solution pops into your conscious brain! Your subconscious had solved it! For more details, click on the subconscious link. There is a 50% chance that your subconscious is smarter than the conscious, so it makes sense to use it; in addition, the subconscious can think about a problem for a long time while you are preoccupied with other activities. There is no known way to talk directly to your subconscious; therefore it is a good idea to practice

using it. One method of practice is to use it when you cannot recall something, such as a person's name. Think about it hard, then let the subconscious do its job – you might be pleasantly surprised, a short while later, when you suddenly remember that name! Since forgetting something is a common occurrence, this will give you plenty of chances to practice using the subconscious, learning to talk to it and listening for it to talk back to you. Now you have a tool for solving difficult problems that your classmates may not have been able to solve.

There are students who copy homework answers from other students, which is not only stealing but also deprives you of the intended benefit of doing homeworks. However, the purpose of doing homeworks is to train you to find answers to problems as quickly as possible. Thus, if you copy answers in order to learn how others solved the problems and learn better methods of completing homeworks, it is not cheating. In college, I discovered that the smartest classmates went to reference books to find answers to homework problems, thus learning material more advanced than presented in class. Thus, starting at about high school, it is a good idea to discuss homework problems with other students and to use reference books (ask the teacher for **reference material**) that will provide better answers than you can by yourself or from the class textbook. I used to think that pondering for hours trying to figure things out by myself would be good exercise for the brain, but that is false because it does nothing to the brain and wastes time. What is more important in life is to develop the ability to find the best solutions as quickly as possible and it doesn't matter how you do it. The knowledge from every textbook and every teacher is limited, and it is good policy to seek more information elsewhere which will make you stand out among your classmates.

Sleep is important to learning because growth and maintenance work are performed on the brain during sleep. The brain is like a car; you can't do maintenance on it while in use, when you are driving it on the highway; you must first drive it to a garage. For the brain, this garage is sleep, when all of its functions are turned off. During sleep, unnecessary or confusing information is flushed out of the brain, leaving only the more important ones – for more details, and how to use breathing exercises to help you fall asleep, see **sleep, section 23**. Sleep is especially important the night before an exam, in order to make sure that the brain functions at its best, just as a car functions best after maintenance is performed on it at a garage.

(5) Exam Preparation: In almost all exams, **the test questions are drawn only from the course material**. Therefore study this material only (usually a text book). Don't worry about homework problems, etc.; just concentrate on the **text book material** covered during the period of the exam. Thus the learning process and the exam preparation have opposite requirements. When learning, it is beneficial to cast a wide net and gather information from as many sources as possible because a single teacher or textbook cannot possibly provide all the information about the subject under study. However, for preparing for exams you must review only the course material because all of the exam questions will be pulled only from the course material – the teacher cannot expect you to know what is not in the course material. Students who study other sources of information on the test subject in order to "better understand the subject" is making a big mistake.

If, within a few days of the exam, you have not learned all the material, **do not try to learn anything new** the day before the exam because your brain will not have the time to understand and digest that material enough to answer exam questions. We saw that learning is basically a memory

process; a complex process with many stages that take time for the brain to execute. For this reason, **cramming at the last moment ALWAYS fails**. Firstly, when you learn anything, it is in short term memory for about five minutes until it is (automatically) transferred to long term memory. This is why head trauma patients can remember events only up to about five minutes before the incident. This process becomes confused when too many things are crammed in, in a short time, it begins to fail, and you have no control over it. After that, because memory is an associative process, the brain automatically starts to associate the newly learned lessons with previously learned material so that they can be recalled, a process that occurs over many days. Without your knowledge, the brain slowly digests new knowledge and files it away! That is why knowledgeable test takers recommend that you go to a movie or do any fun activity the day before an exam, which gives the brain the opportunity to digest the learned material without interference. You will get better results if you only review any work that you have already worked on. This is why procrastination is so damaging.

At the exam, the first thing to do is to **quickly read through all the exam questions** before answering any because the later questions often give you hints about how to answer the initial ones. In order to teach us this lesson, one of my college professors gave us the following exam: it consisted of ten questions; the first two were impossibly difficult, the next seven were easy, but the tenth question stated “In this exam, you will be graded by your answers to any seven questions.”!

Many tests are multiple-choice questions: If you can eliminate some of the items, it is worthwhile to guess the answer among the few remaining choices.

If you first thought of an answer, and then changed it later, your first answer usually turns out to be the correct one, unless you have good reasons for changing; therefore, if you are uncertain as to the correct answer, always stick with the first choice. This happens because the first answer is unbiased. Because there are many wrong answers and only one correct one, when you think too much and pick another answer, your chances of hitting the wrong one is very high.

This is a draft; any suggestions, etc., will be greatly appreciated; email me at cc88m@aol.com.