

Study Daily – Reinforce Your Knowledge

D.J. Dal Bello, Engineering Professor Revision I: 08/20/16. Original: 8/29/14.

“I understood the material when you talked about it in class.”

I have heard this statement many times during my career at AHC, especially towards the end of the semester from students whose grades are not as high as they want them to be (and not as high as they are capable of). Sure it is “easy to understand” in class – instructors usually have studied the topic for years, have taught the course many times, and have already worked out the problem being presented. Students let themselves be *passive observers* instead of *active participants*. They confuse *being familiar* with a topic with *understanding* it.

A related concern is the student who does little, if any, homework. He or she tends not to do well on exams, and thus not well in the class. Then there is the student who does the homework, but does so

only to get it turned in. This student either over-relies on others to help them get through the homework, or works just to get the problems done, instead of working the problems to understand the material. These students **do not spend enough quality time** to learn the underlying principles of the course, nor the general approaches to problem-solving necessary to succeed not only in the current course, but in the next one.

All these problems can be summarized as not reinforcing (actively reviewing) the material sufficiently to perform at the desired level. Obtaining better results typically requires consistent quality effort – studying smart by effectively engaging the material – throughout the entire academic term.

The Forgetting Curve

In the late 1800s, German psychologist Hermann Ebbinghaus performed experiments on memory. He found that when something new was learned (in his experiment, a series of nonsense syllables), within 20 minutes, only 60% had been retained. After 9 hours, only 37% was retained (*Fig. 1*).

Memory, or retention, can be mathematically modeled as an exponential decay with time t . Roughly:

$$R = e^{-t/S} \quad (1)$$

where R is the fraction retained, and S is memory strength. Memory strength can be different for different events; people often remember emotionally charged incidents (if not the exact details) fairly well. As a nation, Americans living in the early 1960s generally remember exactly where they were when they learned President Kennedy was shot. During my teenage years, the highly emotional national incident was the Space Shuttle Challenger explosion.

Think about how you study (learn). Do you:

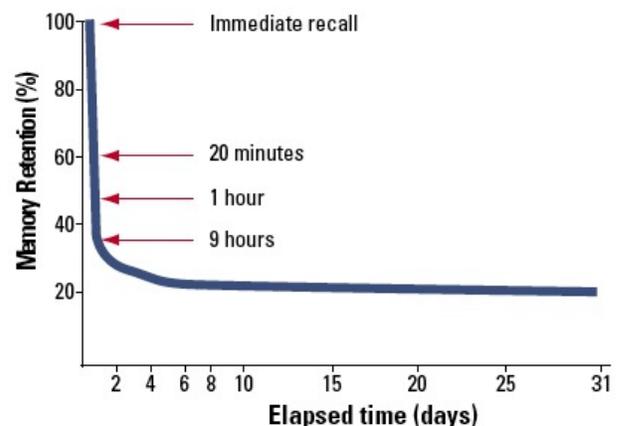
- go to lecture but do not start the homework until several days later?
- not read the textbook?
- read without really thinking about the concepts (i.e., do you read just to say you have read)?

- study with excessive distractions?
- always study alone, and never meet with a group to discuss the course material?

If you answered “yes” to any of these questions, you should consider changing your approach.

What can you do – or what can you do better – that will help reinforce your knowledge?

The forgetting curve



The “forgetting curve” was developed by Hermann Ebbinghaus in 1885. Ebbinghaus memorized a series of nonsense syllables and then tested his memory of them at various periods ranging from 20 minutes to 31 days. This simple but landmark research project was the first to demonstrate that there is an exponential loss of memory unless information is reinforced.

Figure 1. The “Forgetting Curve” (Stahl, et al, 2010).

Leaking Buckets

A pattern students often fall into is **focusing only on one course when the test for that course nears**. They neglect their other courses, intending to catch up later. This is a very bad habit – falling behind in other courses makes life difficult since a lot of material is forgotten.

I have tried to develop a simple analogy to describe this problem. Think about a set of **leaking buckets**. The knowledge and skills you need to learn in a course are like the water with which you are trying to keep the buckets filled. A filled bucket

represents mastery of the course material up to that point in the course. You must continuously attend to the buckets to keep them full – you must study regularly to remain up-to-date with the course. If you do not study continuously and sufficiently, the water (your knowledge and skills) will start to empty out. Neglect a bucket for too long, and you will not be able to refill it in time for the next exam. Consider **Fig. 2** (explanation in the caption).

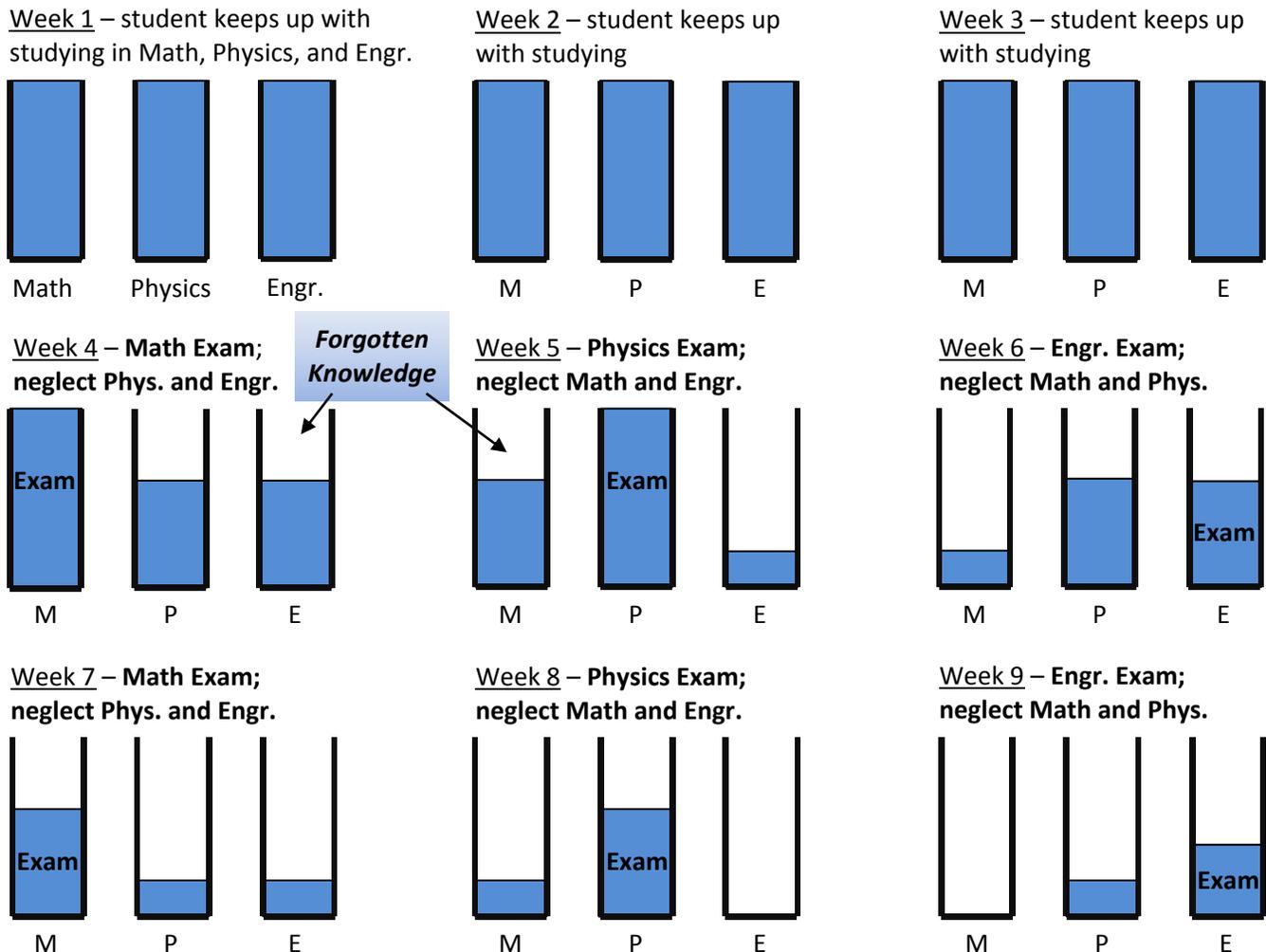


Figure 2. Leaking Bucket Analogy (D. Dal Bello, 2014). Pouring water into leaking buckets is analogous to pouring the knowledge of several courses into your brain. The three buckets above represent three courses: Math (M), Physics (P) and Engineering (E). For simplicity, the model assumes the buckets lose 40% if unattended for a week; i.e., you lose 40% of everything you need to know if you do not study for a week. The model also assumes the student can effectively fill at most 40% of each bucket with quality water (quality knowledge) each week (even if he/she concentrates on only one bucket). All three buckets can be kept filled each week.

During the first three weeks – the buckets are kept full by consistent studying; the student retains 100% of the required knowledge at that point in time.

In Week 4 – a Math exam – the student focusses only on Math and keeps M filled. By neglecting Physics and Engineering, 40% of both P and E leak out. In Week 5, Physics is the focus, and E is down another 40% to 20%. In Week 6 – the Engr. exam – the student is so far behind that only 60% of the knowledge/skill (water) is available for E. The pattern continues. By focusing exclusively on one course, and neglecting others, the end results can be disastrous.

Reinforcement Counters the Forgetting Curve

Repetition or reinforcement increases your ability to remember things. Scientists who study the brain tell us that new brain connections are made when a memory is formed. The more often you reinforce/repeat/review information, the more connections you make, the stronger the memory is, and the longer you will retain it.

The effect of repetition is illustrated in **Fig. 3**. The Forgetting Curve is interrupted by each repetition (with the information remembered assumed to return to 100%). Note that each subsequent Forgetting Curve has a less-steep slope – the memory is stronger with each repetition (S is larger in **Eqn. 1**) – so it takes longer to forget after each repetition. With multiple repetitions, the Forgetting Curve (an exponential decay), is turned into a Remembering Curve (an exponential step function).

So why not just cram? Many students think, “I only have to review once to get back to 100% just before an exam.”

At least two things make cramming a poor choice for studying.

First, you basically need to study from “zero” to get to 100% (or sufficiently high enough to pass the test). The quality of this rushed study is suspect. You may have missed something, and complex interactions are not completely understood. You might remember equations for the exam, but not how and when to (or when not to) use them.

Second, cramming is often only the second or third time the material has been reviewed. The crammed knowledge is easily forgotten, but such knowledge, skills, and problem solving methods – especially in science and engineering – will be needed in the future.

If you study consistently (daily) from the day the material is introduced in class, you can use the day before an exam for a leisurely review instead of a stressed-out study session. Get a good night’s rest.

Consider the following. You would not train your body for an important race by just running the day before. Likewise, you should not train your brain for a test by cramming the night before.

Note that the more repetitions, the more spaced out they need to be as you approach mastery.

Additionally, reviewing the same concept differently (i.e., reading and doing homework problems) – instead of repeating the same study method (just reading) – increases the quality of the memory since different brain connections are made. Also, you will likely understand a concept at a deeper level by not only reading about it, but by applying it. **Applying** concepts requires a higher brain function than just **identifying** them; thus, more knowledge will be retained.

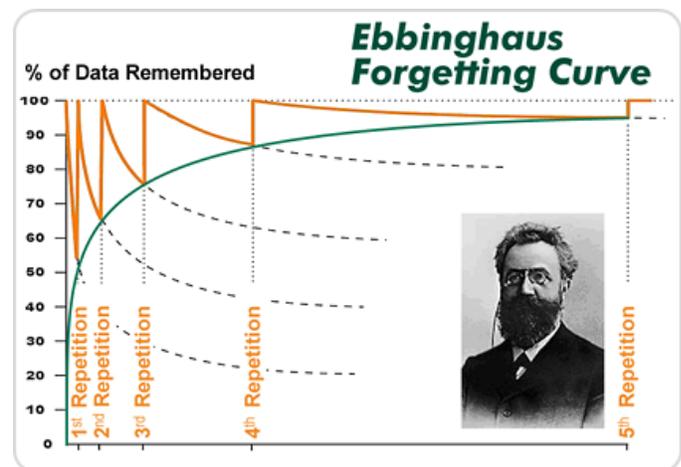


Figure 3. Effect of repetition on the Forgetting Curve: a Remembering Curve.

Reinforcing What You Learn

Hopefully, you are convinced that you should be reinforcing what you learn. You may be thinking, “I already do. I go to class. I read the book. I do the homework”. Perhaps you can study more, as well as study more effectively.

Studying is reinforcing your understanding of the material you are trying to learn. Note that reinforcement (or repetition) does not necessarily mean doing the same thing again and again (e.g., only reading). Reviewing the same

material in different ways is a more effective method of studying.

Studying includes, but is not limited to:

1. Reading the textbook before the topic is discussed in class; preparing for class
2. Attending class, actively listening, taking good notes, asking questions
3. Reading the textbook after class
4. Reviewing your lecture notes

5. Doing practice problems/example problems from the textbook
6. Doing homework problems (and understanding what you are doing)
7. Doing extra problems not assigned in order to encounter new situations and solidify understanding
8. Discussing problems/concepts in a study group; talking through the solution
9. Re-solving homework/extra problems with new values (with a group)
10. Creating problem sets in the group to be taken as if in an exam situation
11. Explaining concepts to others; i.e., “teaching” other students
12. Asking the instructor or tutors about concepts that you are confused about
13. Reviewing homework, especially where there are mistakes
14. Creating a note sheet (whether used in an exam or not), that organizes and summarizes the concepts
15. Reviewing exam problems, especially mistakes
16. Studying related topics outside of class that extend what you learn
17. Watching videos on relevant topics
18. Reading books on the subject
19. Building demonstration models to physically see what is going on
20. ...<your ideas here>

Unfortunately, many students only do *Item 2* and *Item 6*, and sometimes only partially. If you are going through the motions of just coming to class and doing the homework just to get it done, are you really using your time productively? Are you doing enough to master the material? Or are you confusing *familiarity* with *mastery*?

Do you prepare for lectures (*Item 1*)? Lack of time is often used as a reason for not doing so. But if you read the book beforehand (and even attempted some problems or watched a video), would it not be easier to understand the lecture and participate? You would know what is coming, and can ask good questions during class. Even skimming the textbook beforehand would increase the quality of your in-class experience.

Do you attend your professor’s office hours to seek help (*Item 12*)? A 20-minute visit to clear confusion early in the semester is much better than the 40-minute visit towards the end when it is often too late to make significant changes to the semester grade. But remember to first attempt problems. This shows you are trying, and it helps the professor assess where you are at, and what you need help with (do not make the professor have to reteach the entire topic from scratch).

It is painful to instructors when students do not even bother to pick up their homework or exams, let alone review them (*Items 13, 15*). How do these students know what they got wrong? How do they know what they need to work on? Do they even care? It might be scary to see the exam score, but it does not help to avoid what needs to be fixed. A little effort in reviewing what they did not understand, and changing study habits, can usually improve results in that course and the next.

I often wonder why many students often classify “doing homework” and “studying” as *different* activities. Perhaps this explains why some students “do homework” without gaining much understanding of the underlying principles. Homework is seen as an obstacle, rather than another chance to learn. **Doing homework is studying.** Homework is another way of reinforcing the concepts that you are learning.

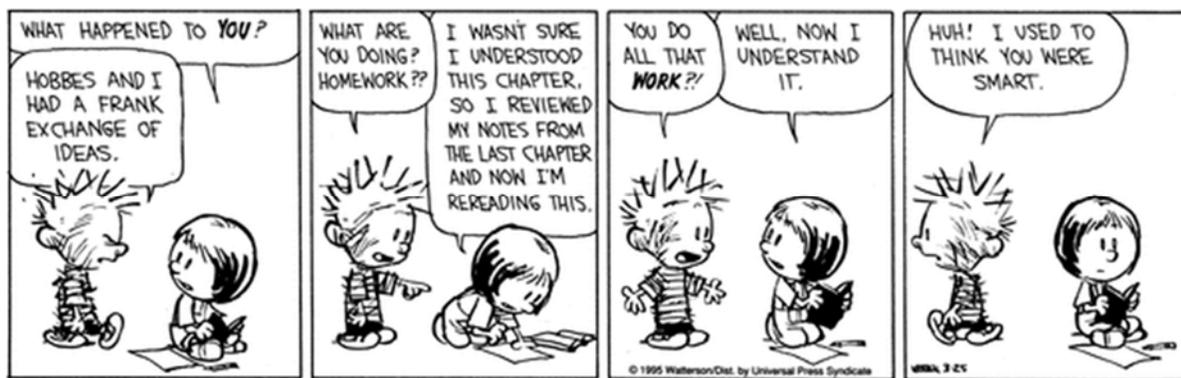


Figure 4. “Calvin and Hobbes”, by Bill Watterson, March 25, 1995.

Learning – the Person Most Responsible is You

Fig. 5 is the *Learning Pyramid*. Researchers have found that people who only listen to a verbal lecture generally retain only about 5% of what is said. Students who only read retain 10%. This does not mean you should not come to class nor read the textbook. Rather, attending class and reading are but two of the many learning techniques that complement each other.

Note that “lecture” in the pyramid means someone at a podium talking to a room of listeners. I use the term “lecture” more broadly to indicate a course held in a regular classroom (as opposed to a lab course). Besides the instructor’s presentation, a good lecture course often includes many of the other items in the pyramid: videos, demonstrations, group discussions, practice and teaching others. So go to class.

Working in groups (50%) provides excellent opportunities to bounce ideas off each other and to try to figure out problems together. Also, you learn skills needed in future courses and your career (teamwork, responsibility to the group, etc.). Engineers and other professionals rarely work on projects alone.

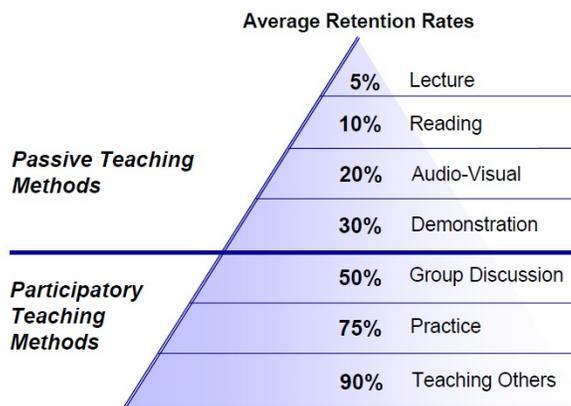
Practice (75%) – doing homework and extra problems – is much more effective than just going to lecture. **You must engage the material**, not just watch someone else work it on the board.

The most effective way of learning is **teaching others** (90%). Teaching helps someone master the material. In preparing class activities – and during class – teachers not only come up with new ways to explain the material, but they often gain new insights to topics they have been teaching for years.

Notice that **the more active the learning – the more the student is involved in the transfer of information – the more information is retained**. Going down the pyramid requires more of the learner, but the outcome is greater. It is true that “You get out of it what you put into it.” The person most responsible for your learning is you.

Practicing – applying what you learn – is vital. You do not learn to drive a car by watching someone else do it. You learn to drive by driving – you have to practice. After a while, driving becomes second-nature. That is what you should be striving to develop in your problem-solving skills. The problems (roads, streets, traffic and weather) might change, but the problem-solving (driving) skills you develop will carry over.

The Learning Pyramid*



*Adapted from National Training Laboratories, Bethel, Maine

Figure 5. The Learning Pyramid. Active Learning (doing) is the most effective.

In AHC Engineering courses, each “weekly” assignment covers about one problem per day. This really should be considered a minimum. I suggest doing twice as many problems to really begin to master the material. Do not wait until the day before it is due to start a homework assignment; you either will not finish, or do a subpar job which will not help you actually learn. Do not “cram” your homework.

My sophomore-level Strength of Materials professor believed in continual practice. The class met Monday-Wednesday-Friday for 10 weeks. Homework was assigned every class meeting, due the next meeting: 3 problems due Wednesday; 3 problems due Friday, and 4 problems due Monday (as he would justify our fourth weekend problem: “What else are you going to do?”). Even at this rate – 1.5 problems/day due every-other day – I had to do at least twice as many problems to get a solid understanding of the material.

Working with groups is important and powerful. Effective group study is not just copying from others. Rather, each group member first works on problems individually. When the group meets, each member is then ready to *discuss* the problems, to work together at solving them (*practice*), to articulate what they do and do not understand, and to explain (*teach*) concepts to each other. Working through problems together helps everyone on the team.

What can you do to improve your learning and your grades? Can you study more? Can you study more effectively? Is your life set up so that you can best succeed?

Setting Yourself Up for Success – Allowing Yourself to Succeed

“But I don’t have time to study more.”

The AHC catalog states that students are expected to spend at least 2 hours outside of class per unit of a lecture class each week. Some college/university catalogues say 3 hours, and for STEM courses, 3 hours per unit per week is probably better. Are you able to devote that time?

To be a successful student, you must **manage your time** and **set up your life to allow yourself to succeed**. This requires balancing any academic, family and work responsibilities that you have, as well as personal time to have some fun to ensure you do not burn out.

Managing your time is not always easy, but **bad time management is often the reason students fail**. Do you waste time? Do you have so much to do each week that your studies suffer? Are there obstacles in your path that prevent you from focusing enough on school? Are you putting obstacles in your path? Is school the right thing for you at this point in time? How many courses can you take and put quality effort into each of them?

In his introduction to engineering book *Studying Engineering*, Ray Landis recommends the *60-Hour Rule*. The 60-Hour Rule essentially states that the typical person has about 60 hours per week that they can perform activities that require some focus – going to class, studying and work. Sixty hours per week is about 9 hours per day, 7 days per week. Since a student is supposed to study 2 hours per unit (per lecture hour in class) per week, each unit is allotted 3 hours per week, while each work-hour is allotted 1 hour.

The 60-Hour Rule is as follows. The maximum number of units u a student should take is:

$$u = \frac{1}{3}(60 - w) \quad (2)$$

where w is the number of work hours. Thus, a student working 20 hours per week should take at most about 13 units ($[60-20]/3 = 13$).

Written another way, someone with a schedule of u units and w work-hours should reach at most about 60 hours:

$$3u + w \approx 60 \quad (3)$$

The 60-Hour Rule is a guideline. Some students can exceed 60, some cannot. But 60 hours of quality work is typical. You may think you can study and work 80 hours per week, but over the course of a semester, this is a recipe for burn-out and failure. If you get sick for one week, you may never catch up, and set yourself back a semester, if not a year.

Note that the 60-Hour Rule is for traditional students (singles in their late teens/early 20s). Students with a family should consider how many hours they need to meet their family responsibilities; w should include family time.

You should also think about scheduling your time by week, being consistent in what you do each week to get into a steady pattern. Transitioning into college can be difficult as life is less structured than in high school. If you make a weekly schedule with regular times set aside for quality studying (and for fun), you will be surprised by how much time you actually have to get things done. Remember, you make the schedule; you decide where and when (and with whom) to study. If your study schedule needs tweaking, change it so you are more productive.

Be smart about how you use your time. Work smart. The time you spend in college is generally considered the best in your life – you learn and experience many new things. College is also when you are investing in yourself so that you will have a better future. Spend your time wisely.

Author’s Notes

I have wanted to write something like this article for my students for a number of years, and was finally motivated to make time to write it by attending a talk by Jeffrey Saikali at the CMC³ conference in Monterey, CA, Dec. 2013. I attach Appendix I of Mr. Saikali’s paper, “Advice to Student for Better Learning, Studying and Remembering” as an appendix to this document. Many of his points are exactly the same as those that I have been trying to get across to my students for years.

Sources

Texts and Articles

Landis, R. *Studying Engineering*, 4th Ed., Discovery Press, 2013.

Saikali, J., “Improving Learning by Understanding the Psychology of Human Memory”, Paper presented Dec. 2013 at California Mathematics Council Community Colleges (CMC³) North Conference, Monterey, CA.

Images

Fig. 1 The “Forgetting Curve”. From Stahl, et al, 2010: “Play it again: The master psychopharmacology program as an example of interval learning in bit-sized portions,” *CNS Spectrums*, Vol. 15, No. 8, 491-501).

http://www.cnsspectrums.com/userdocs/ArticleImages/Stahl_figure1.jpg Accessed July 29, 2014

Fig. 2 Leaking Buckets, the author.

Fig. 3 Effect of repetition of Forgetting Curve: a Remembering Curve.

<http://diogenesii.files.wordpress.com/2012/01/forgettingcurve21.png> Accessed July 23, 2014.

Fig. 4 Calvin and Hobbes “I used to think you were smart”.

<http://www.gocomics.com/calvinandhobbes/1995/03/25>, Accessed August 11, 2014

Fig. 5 The Learning Pyramid. <http://1.bp.blogspot.com/-egZAMUipWC0/TX1Y9fKof0I/AAAAAAAAAEY/bYyGMVQLCFw/s1600/learning%2Bpyramid.jpg>

Accessed July 29, 2014.

NOTES

Appendix I

Advice to Students for Better Learning, Studying, and Remembering

- (1) **Know the prerequisite course material.** Just because you are able (even advised) to register for a course does not necessarily mean that you are ready for it, and assessment tests can be poor at determining preparedness. Too many students enter courses lacking an excellent, current understanding of the preparatory material. Without quickly overcoming this deficiency, it is terribly difficult to master the new material. If you are unsure whether you ought to be in a course, talk to the instructor about it *on the first day of the course or sooner*. Why expect to learn and remember what you are unprepared for?
- (2) **Do not overload yourself.** It has become common for students to concurrently work at a job, go to school, and have family obligations. For some people, these collective demands cause their grades to suffer so that they accumulate a poor academic record. They then may drop out of school, end up taking on long-term responsibilities (such as marriage, having children, or enormous debt), and regret forever that they did not go further with their education. Determine how much YOU can handle and be careful about exceeding it. While some commitments are inflexible, perhaps the stress of other responsibilities can be moderated with help from family members; still others may be possible to reduce or remove from your life. Are you working many hours due to necessity or luxury? Could you scale back expenses, work fewer hours weekly, and still survive financially? Alternatively, taking fewer units of classes per term may mean a longer total time to graduate, but may allow you more time to study, get sufficient rest, and, hence, achieve a better academic record.
- (3) **Resist over-confidence or laziness.** Usually, the first part of any course is its easiest. Even so, there may be bits of knowledge that you need to master. Moreover, when the new material comes, you need to be ready for its challenges. A cocky or lazy attitude may serve only to get you behind. It can be scary and frustrating to find that you are unable to keep up with the new material in a course. Cramming to then retain too much material in a short time rarely works out for students.
- (4) **Come to each session of a class on time and prepared.** This includes completing homework exercises from previous lectures, bringing the homework with you to class, reviewing the last lecture, and reading the portion of the textbook to be covered in the coming lecture. Doing the latter exposes you to terminology, concepts, graphs, and methods that you may hear again in lecture. All of these are important efforts toward learning, studying, and long-term remembering.
- (5) **Exercise good classroom comportment.** Choose a seat where you can stay focused. Do not get distracted by frivolous things or socializing with others. Be attentive to the lecture, discussion, or other class activity. Taking good notes (and actually using them when studying) is important; mindlessly copying the board/screen content to your notebook is not much better than simply photocopying someone else's notes. Instead, think about what you are hearing and seeing from the speaker as you write it. How does it pertain to the overall theme of the lecture? How does it relate to what you knew before the current lecture? How does it relate to what you read in the textbook before coming to class? If you are following all of this advice, and something you hear or see from the speaker is unclear, raise your hand and politely ask for clarification.
- (6) **Elaborative rehearsal is crucial to long-term memory retention.** You can supplement in-class attentiveness by reviewing and audibly pondering the deeper meanings of what you heard in lecture. If helpful, arrange a small study group in which people take turns explaining portions of the material to the group and resolving any confusion. If used properly and practiced every day or two, flashcards can also serve effectively as rehearsal. Re-writing your lecture notes while explaining (aloud or to a friend) each part works well for some people. The more you reinforce and reach a level of comfort in talking about the lecture content, the easier it will be to remember and use what you have learned when tested.
- (7) **Start each homework assignment as soon as possible after its lecture.** Unless you quickly and often use what you hear in the classroom and read in the textbook, you begin forgetting new material about as fast as a new automobile loses value following a consumer purchase. Avoid waiting until the weekend to do multiple lectures' worth of homework. The amount of work can feel insurmountable and leave you getting much less out of the exercises than otherwise possible. You may be inspired to take this seriously by finding online, printing, and carrying with you a copy of the Hermann Ebbinghaus forgetting curve and looking at it frequently. As psychologist Ebbinghaus found a century ago, we begin forgetting brand new material almost immediately (if it is not used in meaningful ways and if we do not relate it to our existing knowledge).
- (8) **Do homework in a distraction-free setting.** Put away devices that draw focus from your work. If you are checking your telephone, social media sites and applications, email, and so on every few minutes, think of how little substantive attention is being paid to what you are supposed to be learning. How much can you reasonably expect to remember later? Make a printed weekly schedule of when to do homework for each course. Carry it with you daily and commit to it.
- (9) **Do homework responsibly.** Start homework by reviewing the new ideas and methods (from the lecture notes and textbook) relevant to the current homework. How does this new content relate to what you learned in earlier lectures, sections of the textbook, and homework? Homework should strengthen the learning of new content, but this benefit comes only if you are consistently responsible with it. Example problems show how to make use of a section's material. It may be tempting to "do" each homework problem by looking for an example problem to emulate without really seeking to understand the relevant theory. Any short-term gain from this practice will be of minimal value during a test when no aids are available. For each homework problem, write the instructions and problem statement, and show all work neatly. When helpful, construct a

Improving Learning by Understanding the Psychology of Human Memory
(SAIKALI, 2013)

table or sketch. If you create a variable, define it. If the problem is a True/False or Yes/No type, justify your answer. These practices will make studying for tests much easier, as you should be able to remember your past work better.

- (10) **Learning is as important as getting the correct answer.** In a career occupation, you will encounter difficult problems that take time to work through. So if a solution approach to a homework problem does not instantly come to you, do not rush to give up. Homework is supposed to be challenging. What would be the objective if all problems had easy-to-come solutions? Before rushing to look in the book, your notes, or elsewhere for a quick answer, stop and think. Are you clear on what you are being asked to do and how what is unknown relates to given information? How might you use previously learned content to reason on the current problem? What role do the components of a problem play in affecting the whole? In the world outside of a classroom, there is no answer set in the back of a textbook. There are no solutions manuals. You may have access to supervisors and colleagues at a job, but if you frequently rush to get help from those sources rather than demonstrating that you can work on your own to solve problems, your assessed value to the organization will be lessened.
- (11) **Stop and ask yourself, “What have I learned?” from homework.** When you complete a subset of related homework problems, take a few minutes to consider what you have gained. What do you know now that you did not know before? Could you teach it to others? Are you able to use what you have acquired to do other problems in this or future sets? Be honest. If you have not learned much from doing the homework, this must be addressed. Telling yourself that everything will work itself out is not the remedy. While there are academic things that take time to mentally digest, it should not be that way generally with your work. Meet with your instructor about this to get advice on what might be wrong. Mathematics courses tend to follow a path of connected learning from one section/chapter to the next. If you do not apply yourself well enough to use and remember what was learned from earlier sections, how can you expect to successfully move forward?
- (12) **Instructor “office hours”.** A misunderstanding of current material will interfere with you correctly learning and remembering new material. If your instructor offers weekly time to meet with students, do you make use of it? Unless you have reason to conclude that it would not be helpful, why not see her/him when you need help? When doing so, be prepared to specify what you do understand and show that you have made reasonable effort *on your own* at figuring out what is unclear.
- (13) **When preparing for a test, spend minimal time studying what you already know well.** A mistake of studying is spending too much time reviewing what you already understand, rather than devoting yourself to mastering material that you are troubled by. It is an unproductive psychological avoidance technique.
- (14) **Familiarity ≠ Comprehension.** While there is value in rereading your lecture notes and the textbook, do not get deluded into thinking that visual familiarity equals understanding/retention. Just because something is easier to read does not mean that you are able to reason on it to solve problems as may very well be required during a test. Also, this kind of narrow familiarity tends to not work well when a person is presented with the same material from a different perspective.
- (15) **Spend sufficient time studying early, and space out study sessions.** It takes time to get knowledge into your long-term memory in a way that makes it easily retrievable in the future. Do not wait until a day or two before a test to start preparing. Cramming is generally not as effective as people assume. Consistently studying daily is more conducive to retention.
- (16) **Short breaks during studying.** Getting distracted every few minutes is an extreme. Working many hours without breaks is an extreme. Find a good place in between. Check yourself along the way to see if you are remembering what you have studied and can demonstrate mastery of it without peeking at notes, books, or answers. If comprehension is minimal, your manner of studying is impractical.
- (17) **Anticipate test questions.** If you are regularly in class, taking copious notes, participating, and responsibly doing the homework, then it could be valuable to spend *some* time speculating on possible test questions. Think about content that the professor has emphasized. Can you explain it to others? Are you ready to be tested on it? Could you make practical use of it extemporaneously? Do not make the mistake of assuming that everything will work itself out during a test. If needed, get clarity ahead of time. Be clear on what content you are expected to know for a particular test.
- (18) **If you use a tutor, do so cautiously.** There is nothing necessarily wrong with consulting a tutor, but be careful. Too often, help from a tutor turns into the tutor doing the student’s work. How can you expect what you need to know to enter your long-term memory and be retrievable during tests if you cannot do much without the tutor’s help? Regularly assess whether it is beneficial to your long-term learning to continue receiving tutoring. A tutor should not be a substitute for working on your own. Is the tutor guiding you in a way that gets you to a point of being able to function independently? (Before you use a tutor, have you exhausted the most obvious source of help, the faculty member teaching the course?)
- (19) **Final advice for tests:** Start studying well in advance of a test. Cramming and all-nighters are risky. Get enough sleep the night before a test. Eat properly so that you are alert and nourished. Gather all necessary tools (pencils, erasers, and so on) well in advance of the test date. If possible, arrive to the testing site early so that you are less stressed. Keep a positive attitude even if the subject matter is not one you are fond of. These will promote your capacity to learn, remember, and do well academically.