How to Study and Make it Stick

A short guide to learning based on the Coursera.org MOOC – "Learning How To Learn"

Introduction

As an extended course work section in the Coursera.org MOOC[1] named "Learning How To Learn", participants are encouraged to reiterate and repeat the contents of the material for peers and others to better spread the information and knowledge as well as to solidify the participants own understanding of the topic at hand.

This document is thereby based on the original work of Dr. Barbara Oakley, Professor of Engineering, Industrial & Systems Engineering at University of California San Diego and Dr. Terrence Sejnowski, Francis Crick Professor at the Salk Institute for Biological Studies Computational Neurology Laboratory. The Coursera.org MOOC is available at https://www.coursera.org/learn/learning-how-to-learn/.

As to furthering this knowledge and hopefully thereby being able to assist my course colleagues in my own higher studies throughout university I am putting this material together for free distribution under a Creative Commons license. Sharing is caring and sharing knowledge is all what education is about in its simplest form. Now it is up to the students to improve and enhance their learning experience.

Finally, I wish to thank Dr. Oakley and Dr. Sejnowski for their interesting ideas, personal attention to excellence and foremost, the fact they have elected to make this information freely available to anyone interested.

Mikael Jörgenstam
Nybro - Sweden, 2015

[1] MOOC is the abbreviation for "Massive Open Online Course" as applied to Coursera.org

Table of Content

Key Topics Discussed

- ♣ Focused and diffuse modes of thinking (What it is and how it works)
- ♣ Key techniques proven by research to help students learn most efficiently (Best practices of the day)
- ♣ Illusions of learning (Whom are you fooling)
- ♣ Memory (Where it all happens)
- ♣ Chunking (How to form a long term memory)
- ♣ Sleep (The importance of rest and breaks)
- ♣ Metaphor, story, and visualization in learning (How to explain it to yourself)
- ♣ Transfer of ideas and concepts from one area to another (correlation and reconnecting to prior knowledge)
- ♣ Deliberate practice (reinforcing the memory pattern)
- ♣ Interleaving (a different approach provides a new foothold)
- ♣ Procrastination (It hurts my brain to do this now)
- ♣ Testing (What did you just learn)
- ♣ Mindset (I know this, why do it again)
- ♣ Working with others in learning (My team is there for me, and I for them)
- ♣ Life-long learning and broadening your passions (I cannot study this, can I?)
- ♣ Learning independently (The steps to get beyond "good" on toward "excellence")

The original coursework also focuses on "Cultural similarities and differences in learning" as a step to provide more knowledge across common cultural barriers. A problem which I personally hope becomes eradicated with more and more MOOC's appearing as an international learning ground on the Internet.

The key topics laid out above will be addressed according the original MOOC's structure and follows closely the work of its original authors. The principle being, it is nothing wrong in emulating the functionality of a working structure, and in particular when related to matters of education.

I. WHAT IS LEARNING

1. What is focused and diffuse learning

Focused learning, in short, is represented by the narrow, intentional learning process where a person adheres strictly to a predefined set of rules and pays little attention to anything but the matter immediately at hand. In other words, studying closely a new topic, adhering to any given rules and techniques which may or may not be known to the student at the present time.

The description above, and what can be read between the lines in the first paragraph shows that it may be suitable for the times when you have a previous knowledge and at least a certain perspective as to what is the requirements for the topic you try to acquire knowledge of when studying.

Diffuse learning, on the contrary is where the student relaxes, possibly not even remotely focusing on the subject matter and as such wanders of in thoughts, digressing freely into other areas and thought patterns. The trick however, to establish a distinct relevance in learning is that one must pay some attention to being "ready" to reconnect to the previous problem or question at a moment's notice. It is as if the thoughts simply strayed for a bit and you find yourself back in the problem solving and solution finding mode of things again.

Oakley and Sejnowski (2015) make a comparative analogy with the brain being a pinball game (see figure 1.1) and in focused mode the ball is thought of as bouncing between very closely placed rubber bumpers in our brain versus a much loser placement of the bumpers when we enter a diffuse mode of thinking. The loosely placed "bumpers" allows the (ball of) thought to pass more easily between the collections of previous knowledge stored while attempting to find solutions in other parts of our brain as we try to establish a form of recognizable solution to the problem.

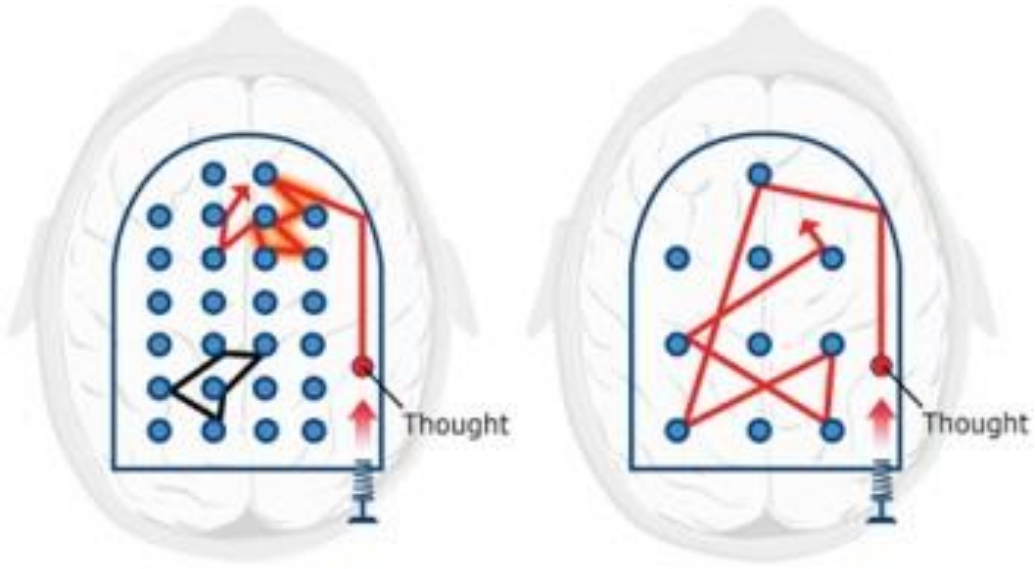

Figure 1.1 Focused vs. Diffuse Thinking, Image courtesy: Oakley and Sejnowski (2015)

The problem which immediately appears is often related to the fact that we have yet to learn the solution to the problem in our own mind and thus to store a memory pattern of the skill or process required to derive a solution or reference to it, latter referred to as a *chunk*. Since there is simply nothing there to form a recollection or perhaps even to derive a solution by puzzling one together for the problem at hand you first have to generate this in your own. We may even have stored the thought or chunk so far back in our memory that we have trouble recollecting it. Memory is after all a form of perishable merchandize which is spoilt easily when not used regularly. In learning this is essential as simply rereading what someone else has learned is not learning it yourself. This will be discussed later in the section on *Illusions of Competency*.

The focused mode of learning is further essential to solidifying the chunk in our memory and as such has a valuable place in learning. In order to study intently and make use of this most effectively in a session of *deliberate learning* requires of course that we have formed ourselves an opinion of the nature of the problem at hand, its techniques employed to approach the problem or even methods to approach unknown and unproven theories in higher educational settings. For this we need to find methods to enter into diffuse mode thinking and study which helps us to form smaller pieces of understanding which, when later practiced become second nature to our management of similar problems in the future. For this reason it is emphasized that chunks are vital to our overall understanding as they form building blocks on which we can derive a complete solution or build a solution method or model over the problem at hand.

The short hand version of the value of chunks is perhaps best depicted, as in the MOOC by Oakley and Sejnowski (2015) when a comparison to well organized thoughts which are easy to recollect are likened with a brick wall with a solid mortar as foundation. The mortar being the time and practice spent on establishing the particular chunks into our long term memory vs. the short term memory space, also referred to as working memory which is very limited.

I will later discuss memory and the various types and uses thereof but suffice it to say for this introduction to diffuse thinking, once we have chunks which can be brought up to memory easily, we can reform them into new and improved chunks which retain less and less need for space in our working memory, thus leaving more space for other idle thoughts and diffuse interactions to flow freely. This in turn enables us to expand our understanding, derive new and complex patterns of memory chunks and perhaps even form a new theory which could possibly win you a Noble Prize one day.

2. Procrastination, Memory, and Sleep

Anyone whom ever has studied any subject or even being presented with the most basic form of task may have encountered procrastination. It is likely a very common trait for human beings, and possibly that of other species as well. Regardless if it is founded in dislike of a particular task or subject matter, plain laziness or simply related to the drab of recurring demands in ones position at work or school. Procrastination can even present itself as a form of reaction closely related to pain centers in the human brain and the effects of dislike is similar to that of a painful experience in the way it manifests itself in our resulting behavior.

We don't like it and "understand it", based on this false perception to be founded in that it "will hurt to do it".

A simple solution, if you have already be afflicted by this from simply reading this paper, then a good course of action, also recommended by Barbara Oakley in the aforementioned MOOC, to employ the *Pomodoro-method*. Set an egg-timer, which often have the shape of a tomato (pomodoro in Italian), to 25 minutes and get to the task by deliberate study. A well-defined period of time, no longer than 25 minutes, without interruptions and in complete focus may very well be your rescue. Remember, as if this section needed any training, to reward yourself at the end of the study session. A piece of chocolate, five minutes web surfing or even a brief conversation with a friend could suffice as a reward.

Procrastination is natural and occurs more or less frequent for everyone. The foundation for it is simply put "in your head" unless you find yourself having elected a course or topic for which you have no desire at all to get through the material. It is not the end of the world and there are ways to avoid falling into the cycle of procrastinating yourself into a failure bound to happen. It is a very different fact when you for instance are faced with a case of depression, or other clinical diagnoses which may manifests itself in other related symptoms. Procrastination can sometimes even be healthy as when you have been active with the same topic or problem for a long period of time. You begin feeling a dislike or discomfort to tackling the problem and put it off. Then do, there is ample proof taking a break is healthy for you, as we find when considering sleep or recess a healthy method for learning more and better.

Our brain is the most energy consuming piece of our bodies, consuming nearly 10 times more energy per mass than any other part. This also means it needs energy to grow, survive and evolve. Contrary to popular belief, brain cells, although they die of at a steady rate, do in some instances actually reform throughout our entire lives. In the hippocampus at the center of our brains for example there is evidence for a daily regrowth of neurons vital for our learning process. This of course provided they are being used and solidified in our mind as part of a chunk in for any number of new memories we gain during our lives. Otherwise they simply die of and become discarded with the rest of the "slush" stored in our brains during the day. Brain cells also have that peculiar configuration to them that they shrink at night time during sleep giving fluids better passage through our heads in order to wash out toxins which otherwise would lodge until we do in fact sleep. This means, gunning for an A following a night of cramming for that very important exam is absolutely setting oneself up for a grand failure.

No Sleep, You Weep
With Rest, You're Best

In particular the long term memory is in dire need of your resting cycles as it is required to take a break for chunks to be processed and form new learned skills. The chemicals in your brain actively seek out to cleanse your short term memory patterns and processing information is in fact done also during sleep. This is when the chunks get solidified and "glued into ribbons" of memory sequences which we later draw on for managing new problems and solutions. Since our memory is configured with a limited range of short term

sockets if you will, it is vital that the ribbons get time to grow and form clear patterns in our long term memory. The longer these ribbons are, the more information we can process at a glance than having to re-form new clusters of chunks using the slots of short term memory space.

This in short describes the contents of the first week and parts of the third week of the MOOC "Learning how to learn" and for any additional reading material, or even to take the quizzes associated with the course, please refer to the URL https://www.coursera.org/learn/learning-how-to-learn.

II. CHUNKING

3. The essentials

The memory of your brain as discussed earlier is made up of a long and a short term space. The long term space being nearly infinite in comparison to our needs for a life times use, in spite of what we sometimes may think when faced with difficult tests. Short term memory on the other hand is extremely limited and for most of us makes use of only approx. four slots of memory space to allocate to random thoughts or active pursuit of new memory. Before chunking of the theories and techniques we wish to learn is done, a swirl of recollection and processing of ideas and thoughts and older chunks occur. This is shown to the far left in the figure 3.1. below. Gradually as our "thoughts become clear" and we get a fair grasp of a concept or idea, the "proper " processes, or those we perceive as suitable to "get the job done" fall into place, as depicted in the center of figure 3.1.

Finally when we have formulated a working grasp of the idea or concept we are trying to learn, we have reformulated the sequence used in working memory into a chunk which then and only then can be held in one single slot of the working memory. Se figure 3.1 far right.

Figure 3.1 – Chunking a memory, Image courtesy: Oakley and Sejnowski (2015)

As we revisit the memory space and our understanding of a specific topic increases and deepens so does also the formed chunk re-form into an even longer predefined set or a swirly spiral in the figure as described. Essential for this to occur is the detailed focused study of

each partial memory segment used in the working memory. Repetition is suitable here but even more so a method called *recall* to let the subject "sink in".

A brief period of looking away from the material and recalling the topic you just read or reviewed is often many times better as a way to solidify the memory of the information. What you missed should then be put on a re-read list but once you have read and understood the majority of the topic, rereading could serve as detrimental for the understanding and instead becomes a foundation for *Einstellung (mindset)* which will be discussed later on or simply becomes a part of *overlearning* as discussed by Oakley and Sejnowski (2015).

Once more, and very important to reiterate, is the importance of sleep for this process of chunking to be completed. You may grasp the subject but not fully have rearranged the thoughts, and there seems to be correlation between sleep and actual dreaming about the topic which further solidifies the memory in a diffused sense. Another method for reiteration is spaced reading or scheduling mini-tests during the periods of study. Recall can be viewed as a form of mini-test when used correctly and consequently. Spaced reading, as the name implies, is a form of repetition however not as cramming for a test, which does very little for long term memory recollections, you should focus on reading several days in a row for an extended period of time, allowing the repetitions to space wider and wider between the occasions you repeat a topic. This is one more argument for doing what you can to avoid procrastination and get to your tasks as soon as you can, leaving more time for rest and repetition.

4. Seeing the big picture

What does the overview and big picture have to do with any memory in particular? Well it is nearly impossible to form any new memories without having a form of overview of the applications and principles when to use the memory. In order to form a "perfect recall" of a memory at the time it matters most, or when you simply need to revisit it to form new and alternate chunks, it may prove highly valuable to form metaphors and analogies related to the topic you are studying. It will help you in holding the memory active in short term as well as revisit certain underlying theories much faster. It also assists you in recalling deeper long term memories once you have certain riddles, metaphors or analogies phrased for their use or application space. Oakley and Sejnowski (2015) also discuss the use of a Memory Palace for "storing" your memories in order to have a method to quickly recollect the technique or process you wish to recall.

In short, the bigger picture of chunking connects the process of forming a theory into a memory for long term storage, into methods used for retaining and solidifying the memory in a deeper area of your brain. Once again, the bigger picture has a two-fold implication as I regard the matter discussed. The first side of the coin being the processed whereby we actually aid our brain to store the information and the other the processes supporting or enabling this being completely fulfilled, such as through proper rest, sleep or exercise or simply a period of disconnection from the problem one is faced with.

As pointed out by Dr. Sejnowski in two different video lectures (Oakley & Sejnowski 2015) this is the number one reason to why it is utterly counterproductive for schools to cut back on recess and or physical activities in school, as it closely relates to the practical solidifying of the topics that school actually is trying to teach the students.

Chunking in short is therefore a combination of diffuse learning coupled with focused learning through a process of deliberate learning to further expand the chunks we have established. Deliberate learning is when you in fact intentionally spend more time on the segments of a matter you know you have a difficulty with. You may understand part of the problem have a few well-formed chunks of understanding and at the same time difficulty applying it to finding the overall final solution in a concept or theory. Do compare the phrase "deliberate studying" with the word "deliberation". It does take a lot of pondering and it must be both deliberate and focused on the issue. At the same time we must not forget the diffuse state, its opportunities, and rest and exercise in between.

5. Illusions of Competency

'Illusions of competency' has nothing to do with that you try to establish an illusion towards external parties of having a competency in a field which you have yet to master. The key word being "yet to master" as you instead have instilled a form of self-appreciation where you in fact rate your own competency as higher than what you have actually achieved or accomplished with your studies. The fallacy has its natural foundation in the stress factors surrounding much of today's higher educational system and also that of lower K-grades. European readers can read K-grade level as grammar school and high school level of studies.

The problem has a solid foundation in that students being innately lazy or too preoccupied with reading to formulate and reformulate their understanding from the materials provided by overhead or PowerPoint presentations into their own words. Instead the student reads and acknowledges the context laid out in the presentation and although they agree on the subject or topic discussed have faulted by not rephrasing and reformulating and reapplying the solutions on a multitude of other problems with similar nature. As such, they may have recognition of the topic discussed but little or no understanding of the subject matter which the presentation intends to clarify or educate on.

The illusion of competency thus relates directly to the actual lack of ability to apply the theory or solution into practical usage and thus the student believes they know it thought in fact they don't. The solutions to this problem are fairly easy to come to terms with in applying any and all of the herein discussed methods of approaching your learning and planning your educational efforts to avoid such fallacies.

6. Einstellung

I promised a short review of the term "Einstellung" (German for mindset) or in my personal view a better choice of English translation would have been "Opinion" as this is what it really boils down to. We have all heard a story of the old warehouse foreman whom refused to move the broomstick to the other side of the warehouse. No matter how many visitors managed to stumble on the thing, it would always find its way back to right next to the

door serving as staff entrance. When asked why he refused to move it, the simple answer was always the same; "-It's always been there since I started here 36 years ago!"
Image courtesy: photoraidz, freephotos.net

Our mindset or opinion must never get the better of us. It is absolutely essential for us, in particular in higher education, to remain open minded and question everything we read and see, hear or believe we understand. So also in the case with the warehouse manager whom only because they have always done the wrong thing, endangering visitors in the meanwhile, pushes on doing the continued wrong thing with the worst reason given of all times. "-We've always done this this way!"

This way I believe I have demonstrated the epiphany of "Einstellung" and we are all guilty of it in some form or another during our lives. Now all cases of predetermined mindsets are not this graphic in nature and far from as dangerous to workers health but it does happen. Imagine for example that you have always assumed one fact about a small arithmetic problem. Thus you solidify it, and perhaps even reuse it for the lack of deeper knowledge in mathematics. Then comes a day when you must venture out in your mind and learn a new way to approach calculus or you may lose your job. Having a fixed or solidified mindset about a fact without having the evidence for it, or even the ability to evaluate such a mindset at times, is counterintuitive of creativity and the process of learning or exploring. You may even easily reconnect back to the prior discussion on illusions of competency and find how this relates to your mindset at times.

With this I have now reviewed most of the second week's syllabus and further touched upon some parts of the fourth and final week's material. If you wish to hear it from "the horse's mouth" I invite you to visit coursera.org for the full set of videos and deeper discussions. Please refer to the URL https://www.coursera.org/learn/learning-how-to-learn.

III. EFFECTIVE LEARNING TIPS

THE POMODORO-METHOD

As discussed and promoted by Dr. Oakley and myself a smart and effective way to maximize your study process as well as counteracting procrastination is to set a timer for a period of 25 minutes. It does not relate much how long you set it to, but until it rings the session is not over and you can force yourself to budge down and work for a predefined "reward" of your own choosing.

Research may in fact say you should not do more than short bursts of 25 minutes. Studies have shown that attention degrades during a school day and many students find it difficult focusing for periods in excess of 40 minutes, in particular in the afternoon classes. With this in mind, setting a timer to 15, 20 or 25 minutes matter little. The main thing is, you HAVE to start somewhere to counteract the little vampires in your mind and once you get started you often notice, your fears and "pains" subside.

START HARD – JUMP EASY

When taking tests many teachers say you should start on the easy questions first to get at least a majority of the answers in on time. This could prove wrong and you may be better served by the approach to review the hard questions first and then jumping along to the easier ones. If you have at least prepared properly for a test following all the other advice given and studied with a purpose to succeed you could benefit from this as your diffuse mode of thinking actually kicks in when you review the easier questions.

With the harder questions still in mind you can go back and catch up from where you left off and possibly having warmed up to the problem during some other questions. The issues are timing and proper preparation.

It is extremely important that you try this at home before engaging for the first time in a live exam room if this method is beneficial to your method of study. As with all educational techniques a proper understanding of the methods before they are applied to your practical performance is almost always a pre-requisite for setting yourself up for success rather than failure.

BREATHING – As vital for testing as life in general

If you experience stress and anxiety when you enter a test or even the hours before a test you should beforehand make yourself aware of a few simple breathing tricks. Placing a hand on your belly and breathing in deeply so that your entire torso seems to fill up with air in a slow and controlled fashion help reduce stress hormones in the body and you can easily get rid of those sweaty palms and mood shifts which follow anxiety.

Getting control over your own emotions is important and helps you gain control over those fight-or-flight instincts our primate ancestry has given rise to. In matters of tests where you are hard pressed to read a question and only provide the sought for answer, it is often difficult when your anxiety pushes you of track and the responses instead appear as digressing from the sought after, often short, responses that gives good marks on tests.

Dr. FELDERS TEST CHECKLIST

A very valuable tool to help you prepare for tests include Dr. Felder's (1999) test preparation check list[2] for students. According to Dr. Felder to do well on tests you should, as Felder puts it, "Do whatever it takes to be able to answer "Yes" to most of the questions".

Furthermore this Yes should only apply to what you usually do, not occasionally or never. On the next page you will find a check list which you can print out and use for checking that you actually follow your study plan properly.

[2] Dr. Richard Felder, NCSU, developed this checklist for chemical engineering students but it is found applicable to many other fields and highly relevant to all kinds of testing and exams.

Test Preparation Checklist (Felder 1999)

Answer "Yes" only if you usually did the things described (as opposed to occasionally or never).

Homework

Yes No	*1. Did you make a serious effort to understand the text? (Just hunting for relevant worked-out examples doesn't count.)*
Yes No	*2. Did you work with classmates on homework problems, or at least check your solutions with others?*
Yes No	*3. Did you attempt to outline every homework problem solution before working with classmates?*
Yes No	*4. Did you participate actively in homework group discussions (contributing ideas, asking questions)?*
Yes No	*5. Did you consult with the instructor or teaching assistants when you were having trouble with something?*
Yes No	*6. Did you understand ALL of your homework problem solutions when they were handed in?*
Yes No	*7. Did you ask in class for explanations of homework problem solutions that weren't clear to you?*

Test preparation

Yes No	*8. If you had a study guide, did you carefully go through it before the test and convince yourself that you could do everything on it?*
Yes No	*9. Did you attempt to outline lots of problem solutions quickly, without spending time on the algebra and calculations?*
Yes No	*10. Did you go over the study guide and problems with classmates and quiz one another?*
Yes No	*11. If there was a review session before the test, did you attend it and ask questions about anything you weren't sure about?*
Yes No	*12. Did you get a reasonable night's sleep before the test?* ***(If your answer is no, your answers to 1-11 may not matter.)***

___ ___	*Total count of responses in each column*
Yes No	

The more "Yes" responses you recorded, the better your preparation for the test. If you recorded two or more "No" responses, think seriously about making some changes in how you prepare for the next test.

Life Long Learning & Broadening Your Horizon

As a final entry to this long review and summary of key topics for the MOOC "Learning How to Learn" I will discuss a few personal reflections and some of the underlying key topics Dr. Barbara Oakley and Dr. Terrance Sejnowski really drive home in the 4 week video sessions.

"You are never too old to learn something new and secondly, you should definitely try to expand your vision and improve your confidence by studying what 'You' are interested in, not what 'Others' may assume you may be suited for. As for studying languages, it is as easy as being 4 years old or 48 years old. It is just a question of not being afraid to make a fool of yourself in front of your peers for a few months. Once you stop learning is the day you start dying!" – Mikael Jörgenstam[3]

I have always had the personal attitude as to follow the above stated and I am a firm believer the human mind is made to absorb, expand and alter throughout a lifetime and never really reaches its assumed limits of learning. Of course the exception being when illness and accidents set a major stick in our proverbial "Wheel of Time", as the phrase goes once coined by Robert Jordan. In fact, I am often heard stating my belief that when we stop learning is the first day in our life when we start dying a little bit every day.

As Dr. Oakley so elegantly put it in the series of videos for this MOOC, we should learn to broaden our minds and pursuit our passions regardless of what others perceive us to be suited to do. Equally so, it is a journey for life.

On a whole different side note I was fascinated with the interviews following the weekly short video clips, in particular the clip with Dr. Oakley interviewing Dr. Norman Fortenberry on his ideas and experiences. I found myself somewhat taken by the fact that I actually agreed with his statements so much more than I ever did once upon a time back in high school.

Motivation and an aim for a higher education is dependent on the students motivation and desire to acquire knowledge, much more than it is the role of the professor or teacher to provide the lit path to information and skills. It is a matter of learning, and no one else can do that for you but yourself!

It is also funny that up until this interview I firmly said I have so very few regrets in life. Now instead I say; "I have so very few regrets in my life, but not aiming for a higher education much earlier in my life is one of those I never will forgive myself for."

Now there are no excuses left,
move along and relax while doing it!

[3] Quoting myself for good form in order to please the teachers eager to instill the Harvard system in me ☺

References

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