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A NEW SIMPLE METHOD FOR AN EFFICIENT ORGANIZATION OF THE LEARNING PROCESS

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ABSTRACT

The most appropriate learning results take place when the trained matter is unmistakably identified, understood and achieved by the student. An individual learning process should be developed by the trainee, in parallel, by self-inspiring and by involving his own capabilities through natural mind procedures. In addition to motivation and pertinent chances which operate as a learning means, practical suggestions gained by the authors through experience and specific studies were used to develop a new suitable method of study organization.

In this article, after an introduction in which some existing methods were reviewed related to learning and study planning, a novel simple method is presented, which has been successfully experimented for years. Such an approach has proven to be valid to achieve the main purposes, i.e. learning, passing exams successfully, remembering as long as possible the technical and cultural knowledge studied and applying efficaciously the acquired wealth of knowledge in the future professional life.

KEY WORDS

study organization, learning method, memory, neurobiology, connectome

CLASSIFICATION

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INTRODUCTION

The learning process involves all our senses and is an inner occurrence both on a mental level and as a human activity with significant effects on career and life. Proper motivation and substantial circumstances act as a learning means. Appropriate activities contribute to strengthening the learning process and making it easy. These activities should be advanced based on the aptitude of the student and multi grade environment [1].

A review is preliminarly presented of the main learning approaches currently available in scientific literature and provided to help the learning process on an individual, team or organisational level. The criterion with which these approaches were selected was to find method for study organizations (MSOs) that through successive phases were conceived to gradually lead the student to complete learning of the subject.

The so called discovery learning methods, e.g., are components of educational practice promoting the way to active learning that is process oriented and self-directed [2]. These methods are based on the idea that students create their own understanding and knowledge through experience and reflect on those experiences, thus interacting with their environment and being stimulated to think, hypothesize, raise questions, speculate and cooperate with others, developing confidence in problem solving [3]. A concise learning method exists, e.g., based on the use of mind mapping to integrate all class notes into mind maps, and also learning some success skills [4]. Such methods use an active, cognitive, inquiry-based constructive process, avoiding passive and dull memorization. This considers learning as a multi-phase process in which the student organizes and connects basic concepts through visual maps by critically thinking and asking key questions [5]. A learning approach is also included in the so called “mind map” thinking tool, which is a form of note-taking that can be adopted where linear notes would normally be taken, such as when carrying out research, studying or attending lectures [6].

Various experiments have been carried out in the world to analyse the learning process. Metacognitive skills or strategies were investigated, e.g., considering 400 university students randomly chosen from different schools and departments of the Gazi University, Turkey, in 2012. Their selection was performed according to their perceived self-confidence levels about learning. Those possessing higher self-confidence in their capabilities got better results using the strategies of note taking, summarizing, reflecting, reciting and reviewing what they learned, in combination with things they had already known, being able to approach complicated tasks as challenges to be mastered [7].

During the advancement of the school career, e.g. passing from high school to university studies, students need to manage their instruction ever more and involve rising energy into becoming self-managing learners. Essential study and organizational skills are needed to divide class and homework duties into subtasks and to use time proficiently to complete duties like storing classified papers and other texts for postponed retrieval, habitually reviewing class notes and course readings, and practicing efficient study techniques. Some concepts that can allow one to study more effectively and to become more organized have been reported in [8] and the following learning methods can be mentioned as further examples:

- *the case study method*, a learning technique in which the student conducts an in-depth examination of complex phenomena within some specific context and real situation (i.e., the case), analysing it and using real information as a methodological tool [9];
- *the Pomodoro study method*, a time management technique that involves using a timer to time short, intense work sessions, traditionally 25 minutes long [10, 11];

- *the Feynman learning technique,* in which the learning process happens through the act of teaching. The students choose a topic, then explain it in their own words as if teaching, then they improve their explanations and go through the process again until they have mastered the topic [12];
- *the PQ4R method*, adopted to read and to comprehend detailed scientific texts, with emphasis on understanding and retaining the content and not on the reading speed: the letters P, Q and 4×R mean the 6 different steps needed to work through the text [13];
- *the SQ3R method,* in which the student is expected to develop his understanding of the text by purposely engaging in the reading process before, during and after: the letters S, Q and 3×R mean in this case the 5 different steps needed when actively and effectively reading a specific text [14].

In recent years, digital learning materials and auxiliary resources have been developed such as slide decks, videos, simulations, worksheets and test banks, as well as all-inclusive, stand-alone online solutions, enabling students to complete assignments, to get automatic feedback and to engage with their classmates and instructor. Learning materials, anyhow, should be adequately contextualized: courses assembled by collecting materials coming from multiple sources. This is unlike a commercial or open textbook, may not have built-in summaries, timelines, background information or the explicit interpretation necessary to help students to fully comprehend the subject. To facilitate student learning, thus, the preparation of a contextual commentary is suggested, e.g., by adding the content in the form of recorded or written lectures, or by embedding it into discussions and other learning activities [15].

The best study program, however, is undoubtedly the one customized according to the needs of each student, even in the sector of higher level studies, due to the different course programs and skills of the specific student. Learning and memory, anyhow, have neurobiological bases that are favoured and developed by applying a new dedicated simple MSO, which has been meticulously developed and refined during university studies, and will be presented in the next section.

THE NEW SIMPLE METHOD FOR STUDY ORGANIZATION

This MSO is our original method, a valid learning tool which has been successfully experimented in Italy in various disciplines especially during graduate studies, i.e.: in the ‘80s, in Mechanical, Electronic and Civil Engineering at the University of Ancona and in Aerospace Engineering at the University of Rome; in the ‘90s, in Nuclear Engineering PhD studies at the University of Bologna. Such MSO has allowed all the dozens of students who have adopted it to pass university exams brilliantly and it can be generally applied to diverse higher and graduate studies. With respect to the previously existing methods, this MSO helps: solving the problem of correctly meeting the times available for studying and in particular the deadlines for exams; optimizing these preparation times and helping to acquire a deeper knowledge of the subject studied, fixing it in long-term memory; avoiding showing up unprepared for exams or obtaining unsatisfactory results. It is composed of five successive phases to be faced, by the student, with appointment and enthusiasm for the matters that must be learned.

PHASE 1

Know exactly what you must study. Collect, therefore, all the necessary material: personal notes from lectures given by the teacher of the course, books, diagrams, various drawings, additional notes and anything else recommended by the teacher, who should be consulted, especially to dispel all doubts.

You have to reach the sureness of having all the necessary material to tackle the study.

PHASE 2

Read and fully examine the material collected in Phase 1, only trying to understand. You should not read on if you do not clearly understand a concept, a formula, or even a word. Before you go on, you need to clarify the meaning of what has been read. The aim of this phase is only to understand everything that is written, without trying to remember or memorize.

PHASE 3

Write on a dedicated notebook the summary of the examined texts. This is the most important and responsible phase. The summary must be drafted very correct and as clearly as possible so to later study it directly. The same summary must collect fully all the considered concepts, ideas, issues, principles, rules, theorems and formulas, highlighting also the main purpose of the course so as to overcome any questioning as well as the final examination.

Even at this phase, so as not to bring the notebook texts that do not affect the required arguments, if in doubt you should consult the teacher of the course and, possibly, those who have recently passed the exam successfully. It is recommended to write down in a notebook also all schemes - technical, logical, etc. as well as drawings and graphics to be studied, trying to use different inks to improve comprehensibility.

It must succeed, hence, to no longer need the material collected in Phase 1, except when the same presents exercises to solve. Such exercises are to be addressed in parallel to the study as soon as one possesses a full knowledge of the topics to which they relate.

PHASE 4

Study the contents of the summary notebook prepared in Phase 3, in order to remember what you have already understood – and partly automatically stored in your mind – through the preparation of the same notebook.

It is advisable to carry out the study as follows: repeatedly and carefully reading medium voice sentence by sentence, as if you were facing the examiner; then, repeating in a middle voice what was just read several times enthusiastically, as if you were to ask a person who does not know the subject.

Write several times the mathematical formulas that may be present in the text, to learn along with their precise meaning and the units of measure of each symbol present. The same applies to the charts and drawings to be studied.

During this phase, list separately and very carefully all the concepts, formulas and generally all the parts that result that are difficult to understand or remember.

PHASE 5

Refresher. Re-read the whole notebook, pausing at each of the difficult points already mentioned during the study with reference to Phase 4, then re-studying them to dispel any doubt.

This phase is also required to form mentally and quickly a complete picture of all the topics covered.

The same phase can also be repeated more than once, to retain maximum clarity of the exposition of the subject, together with an appreciable readiness for the exam.

ADDITIONAL PRACTICAL SUGGESTIONS

Keep the best hours of the day for the study. Phases 2, 4 and 5, in particular, should not be addressed if tired, sated or nervous.

Study quietly, focusing solely on the above subject and avoiding any chance of diversion as background noises, loud and distracting music, conversation, smoking or a phone not on silent. The best sound for productivity is silence. A break can be taken every few hours to listen to music, e.g. for 15 minutes [16].

Organize a study schedule, postponing other types of commitment out of the involved time. Phases 2, 3 and 4, in this regard, can be divided according to a schedule of study, to be prepared in order to reserve a right margin of time, before the examination, to refresh and rest. See, e.g., Table 1.

Table 1. Example of simple subdivision of the study calendar.

	Wednesday Mar. 06	**Thursday Mar. 07**	**Friday Mar. 08**	**Saturday Mar. 09**	------
morning	Phase 2 Book XXX pages 251-300	Phase 2 Book XXX pages 351-400	*rest*	Phase 3 Book XXX pages 21-40	**……**
afternoon and evening	Phase 2 Book XXX pages 301-350	Phase 2 Book XXX pages 401-fine.	Phase 3 Book XXX pages 1-20	etc.	**……**

The calendar should be organized by everyone of the students according to their ability to study. The same calendar is useful especially when you have availability for studying on a specific period of days. Once established, the timing must be respected rigorously recovering any delays and anticipating the study where possible.

During the last phases of study, strictly avoid any occasion of hours of sleep loss, alcohol, smoking, considerable physical effort and sleeping pills or medicines. Secure, however, the right intervals of relaxation and refreshment.

It is advisable to study alone, though colleagues can be consulted if necessary, but after having already studied solo. Only then, from the comparison and verification with colleagues can one get the right benefit.

NEUROBIOLOGY OF LEARNING AND MEMORY IN THE MSO CONTEXT

This MSO encloses all the components that represent the neurobiological basis of learning and memory, see Figure 1.

The enthusiasm activates the emotional memory whose anatomical seat is in the amygdala, which is stimulated by impulses internal and external. The enthusiasm also “colours” the memory traces interpreting them according to the subjective language of emotions, recording sensory data through the connections with the thalamus, hypothalamus and hippocampus [17]. The structures most responsible for memory processes are the hippocampus and the amygdala, two subcortical structures in the temporal lobe, which are part of the limbic system. The hippocampus plays a primary role in the formation of short-term memory, but not of long-term memory. The amygdala, on the other hand, attributes a particularly affective and/or emotional meaning to information, consolidating it over time. The amygdala also makes it possible to associate a stimulus with a reward or a penalty [18].

Memory is initially stored as a transient change that can consolidate into a long-term memory trace. Consolidation largely depends on the emotional state. The interaction between these two structures, the hippocampus and the amygdala, is crucial in many forms of learning and memory. The hippocampus, as well as the amygdala, exhibits a type of synaptic plasticity known as long-term potentiation (LTP). Recent studies have shown that hippocampal LTP consolidation can be modulated by the emotional state and activation of the amygdala [19]. Calm, silence, solitude and concentration all reduce stress and lower blood cortisol levels.

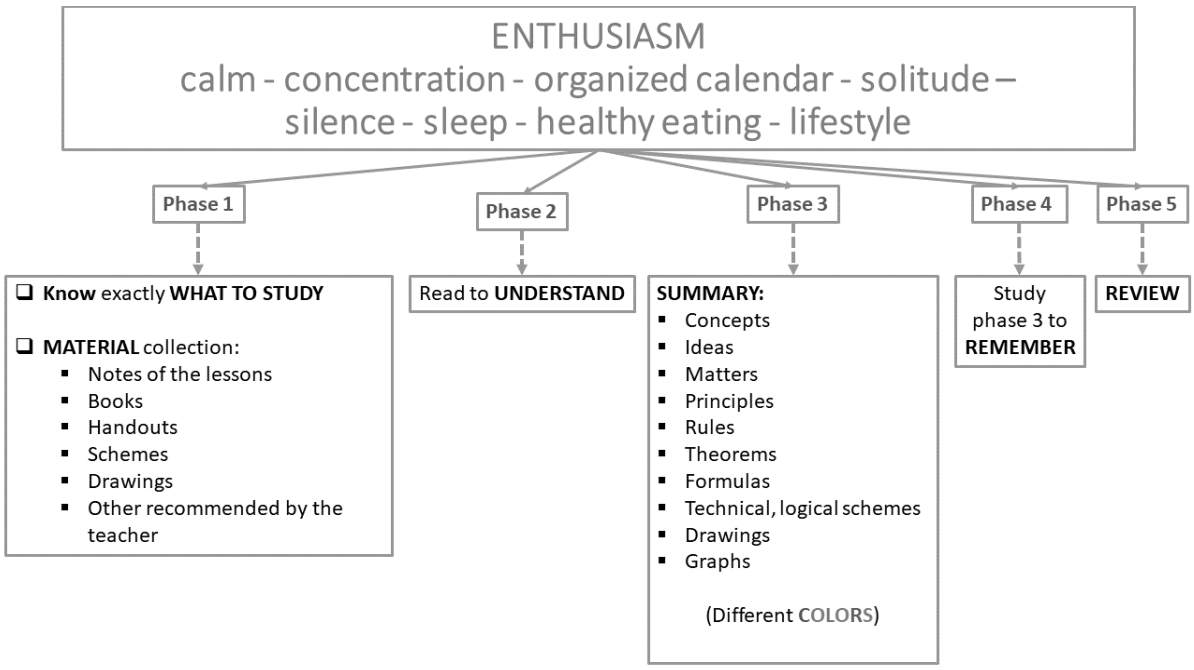

Figure 1. The 5-phase scheme of the MSO: 1 complete collection of the texts to be studied; 2 reading of the collected texts to understand their meaning; 3 drafting the summary of the examined texts in a notebook also containing diagrams, drawings and graphs; 4 study and memorization of the summary; 5 repeated review of the summary.

The hippocampal system is very sensitive to stress and memory can increase or decrease based on the subjectively perceived feeling of stress [20]. Acute stress prevents memory centres from recovering certain types of memories [21], while in chronic stress the high concentrations of cortisol are associated with an excessive release of excitatory neurotransmitters, resulting in a reduction in neuronal trophism and inhibition of neurogenesis [22].

The organized calendar of this MSO, together with a healthy diet, good sleep quality and a lifestyle based on moderate physical activity free from smoking, alcohol, etc., they favour a perfect psycho physical shape and optimal cognitive performance.

It is also important to choose the place to live and study in order to receive the correct environmental epigenetic stimuli [23, 24]. Moderate calorie reduction is recommended, as excess calories can reduce synaptic plasticity. It is suggested to prepare light meals based on seasonal foods rich in active ingredients such as:

- B vitamins, to protect brain function by reducing blood levels of homocysteine (*eggs, chicken, fish, vegetables*);
- C vitamin, is useful for brain tissue and to manage stress (*black currants, peppers, citrus fruits, broccoli*);
- E vitamin, is useful to protect synaptic membranes from oxidative stress and improve cognitive performance (*extra virgin olive oil, nuts, almonds, Brazil nuts, hazelnuts, flax seeds, olives, eggs, green leafy vegetables, unrefined whole grains, especially spelled and oats*);
- K vitamin, to improve cognitive function (*cabbage rich in glucosinolates able to maintain high levels of the neurotransmitter acetylcholine at the synaptic level for a healthy brain and clear memories*);
- Zinc, Magnesium and Tryptophan, precursor of Serotonin, to increase memory, thinking skills and good mood (*pumpkin seeds*);

- Omega 3, to preserve synaptic function and the plasticity of neurons (*walnuts, flax seeds, oily fish, pumpkin seeds*);
- Alpha lipoic acid, for antioxidant effects (*spinach, broccoli*);
- Lycopene, to prevent damage from free radicals (*tomato*);
- Tannins, Anthocyanins and Phenols, to increase short-term memory and promote the regeneration of retinal purpura (*blueberries, blackberries*);
- Spices, to improve memory and concentration (*sage, rosemary, turmeric, chilli pepper*) [25];
- Astaxanthin, to protect the retina and cell membranes. Furthermore, astaxanthin activates the FOXO3 gene also called the "longevity gene" [26]. A neurogenesis of the hippocampus has been observed in the elderly treated for 4 weeks with this substance (*crustaceans and salmon*).

Meals with a high saturated fat content (meat and cheeses) are not recommended, since they reduce the molecules useful for cognitive processing [23]. Proper hydration is important by drinking at least 1,5 litres of water a day.

Good sleep quality is of paramount importance for physical health, mental well-being, attention and creativity [27]. Sleep loss (total or partial) impairs performances such as working memory, alertness and cognitive performance, moreover inducing an all-round decline in attention [28]. Moreover, moderate physical activity reduces oxidative stress (i.e., excess free radicals) and nitrosative stress (i.e., excess of nitrogen monoxide), improves neuroendocrine self-regulation by counteracting neuronal degeneration [29], releases stress, increases endorphins, improves blood circulation and stimulates the "anti-aging" activity of sirtuins which promote neurogenesis [30].

The preparatory subdivision of the study into the 5 phases creates a construct on which to organize a rhythmic and rational guide for the study; furthermore, thanks to the information sent to the brain in the form of summaries, logical diagrams, drawings and graphs, it favours the formation of the brain maps of the connectome through a progressive reconfiguration of the neuronal circuits.

Neural networks normally require huge amounts of data to build their complex mappings (connectome) so memory augmented neural networks improve connectome maps [31]. The connectome is a dynamic mapping of neural networks that is strengthened and updated with experience and learning [32]; its study and coding began in 2009, by H.S. Seung, in the Department of Brain and Cognitive Sciences and the Department of Physics at the Massachusetts Institute of Technology.

The neuroimaging methods used, Resting-state functional connectivity fMRI [33], to analyse the mechanisms of grey matter and Diffusion imaging for the study of white matter – allow representing the axon bundles in different colours depending on the direction of the synaptic flow.

Prof. Seung has schematized the plastic reconfiguration of the connectome according to 4R:

R_1) Reweighing: neurons adapt (or reweigh) their connections by strengthening or weakening them through variations in the number of neurotransmitter vesicles in the synaptic terminations (see Figure 2);
R_2) Reconnection: neurons reconnect by creating or eliminating synapses;
R_3) Rewiring: neurons reform new circuits (rewire themselves) by making branches grow or retract;
R_4) Regeneration: creation and elimination of neuronal cells [34, 35].

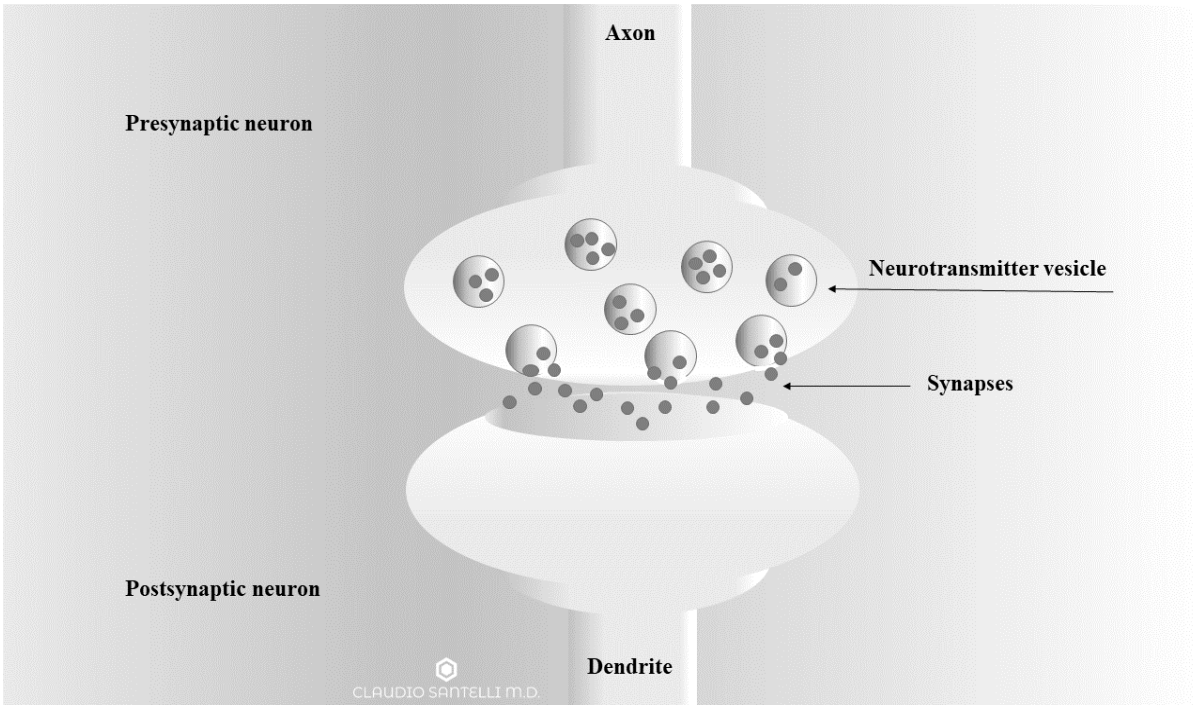

Figure 2. Synaptic connection between an axon of the presynaptic neuron and a dendrite of the postsynaptic neuron. The number of vesicles containing the neurotransmitter that is released in the synaptic space varies according to the cognitive stimuli received.

These neurophysiological models originally inspired the construction of the neural networks of artificial intelligence where, in neuromorphic chips that process algorithms and computational mathematical calculations, the "deep-learning" takes place in the latest generation computers and robots capable of processing functions and dynamics by learning from experience and examples [36].

The use, in this MSO, of graphics, colourful diagrams, drawings, symbols, etc., activates mirror neurons and advances eidetic memory based on visual perception. Mirror neurons allow one to understand the meaning of physical actions among peers and constitute the neural basis of learning by imitation and empathy [37]. The signals associated with the figures in the drawings, through the hypothalamic neurons, stimulate the brain to form memories of objects [38]. This aspect is also the basis of neuroaesthetics, a discipline founded in 1994 by S. Zeki, University College London. In 2004, together with H. Kawabata, by using the Functional Magnetic Resonance technique, he noticed an increase in metabolic activity in the orbitofrontal regions of a person's brain while observing artworks [39].

There are many anecdotes about famous cases of eidetic (visual or photographic) memory in adults. W.A. Mozart, e.g., was able to reproduce a symphony after having listened it only once (in this case, we refer to eidetic memory for sounds) [40].

Also the Italian humanist and philosopher, Pico Della Mirandola (born in Mirandola, February 24, 1463 and died in Florence, November 17, 1494), remained famous for the ability to make complex calculations without writing anything and for the many works he knew by heart [41].

CONCLUSIONS

The described MSO provides students with a solid basis for the implementation of practical training. Enthusiasm strengthens the emotional memory, while calm, silence, solitude and concentration avoid the distress and the consequent hormonal increase of cortisol.

The organized calendar together with a healthy diet, a good quality of sleep and a lifestyle based on moderate physical activity free from smoking, alcohol, etc. favour a perfect psycho-physical shape and optimal cognitive performance.

The subdivision of the study into a sequence of 5 phases creates a construct on which to organize a rational and preparatory learning guide. It also stimulates the formation of brain maps of the connectome through the progressive reconfiguration of neuronal circuits similar to the deep learning mechanism of Artificial Intelligence, which builds its own neuromorphic chips by mimicking the dynamic neuronal circuits of the connectome.

Graphics, colour schemes, drawings, symbols, etc., finally, activate mirror neurons and eidetic memory based on visual perception.

Researches related to anti-aging are currently oriented towards improving life's quality and health's duration. In addition to promoting healthy lifestyles, therefore, future research activities should be devoted to the study of senolytic products and supplements to improve executive functions and cognitive abilities of healthy individuals, e.g. attention, creativity, memory, mood and motivation.

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