8 Pillars X 8 Layers Model of Metacognition

Educational Strategies, Exercises &Trainings

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Abstract—Metacognition is one of the foremost cardinal factors of achievement in the 21st century. Despite extensive research, there is still the need to build a unique model based on multidisciplinary research illuminating questions as regards the real nature of metacognition and the methods to develop metacognitive abilities. The current study presents a new layered model of metacognition based on well-established theories derived from cognitive science, psychology, physical and computer sciences, environmental and other sciences, even from philosophy. We describe in detail the cognitive and metacognitive processes involved at each layer, while particular emphasis is placed on the relation between the control processes as well as the special role of attention. According to our model, each layer of metacognition describes a higher-order control system which operates under the rule of a series of attention processes at an ever more refined, abstract and united level. The same applies to the cognitive processes and abilities such as attention, memory, perception, pattern recognition. At each higher level, they display more advanced attributes and functions responding to the necessity of creating more abstract mental representations and upper class motivations, thoughts and emotions. In addition, we recommend a number of strategies that support the metacognitive development at each level of the hierarchy. The multi-layered model of metacognition targets at enriching our understanding of how metacognition evolves and it has the potential to guide the development of more effective strategies in educational system.

Keywords—layers of metacognition, intelligence, consciousness, executive functions, meta-attention, meta-memory, meta-motivations, information processing, control systems, intervention strategies and techniques

1 Introduction

Many researchers have attempted to develop theories and models of metacognition. Flavell [1] recognized that metacognition consisted of both monitoring and regulating aspects. He proposed a model of metacognitive monitoring which includes the following components: *metacognitive knowledge, metacognitive experiences, tasks or goals and strategies*.

Norman et al. [2] underlined the primary role of attention in the control processes. They proposed an executive function model comprising two levels of control: *a supervisory attentional mechanism* monitoring and manipulating automatic processes and a *contention scheduling mechanism* selecting among competing schemas.

Brown [3] presented a metacognitive model based on two components*: knowledge and regulation of cognition*. Knowledge of cognition depicts the conscious reflection on one's cognitive abilities and the regulation of cognition relates to the self-regulatory mechanisms during the ongoing attempt to learn.

Nelson and Narens [4-5] suggested an alternative model of metacognition consisting of two interrelated levels called *the object level and the meta-level*. There are two dominant relations between the levels known as "monitoring" and "controlling". Metacognitive monitoring is a flow of information from the object level to the meta-level whereas metacognitive control is depicted as a flow of information from the meta-level to the object level.

Shimamura [6] developed the dynamic filtering theory, the neurocognitive counterpart of Nelson and Naren's model [4-5]. The dynamic filtering theory proposes that the prefrontal cortex acts as a filtering mechanism that controls information processing.

Drigas et al. [7] presented an integrative model of human knowledge, intelligence and consciousness. According to the aforementioned model, intelligence is not regarded as a static or one-dimensional concept. On the contrary, it could be represented with a dynamic and multi-layered structure dependent on metacognitive procedures. The Knowledge-Intelligence-Consciousness model is the uniformity with the ISO's Open Systems Interconnection Model, a conceptual framework describing the functions of a networking system through a universal set of rules [8].

Recognizing the fundamental role of metacognition in human intelligence, Drigas et al. determined the core components of metacognition [9]:

1. Deep theoretical knowledge about human cognition and metacognition
2. Self-evaluation of the factors that either facilitate or inhibit the metacognitive development.
3. Self-observation of the cognitive and psycho/physiological mechanisms
4. Self-regulation of any dysfunction that is observed
5. Adapting one's own cognition in response to changing circumstances
6. Recognition of the totality that exists beyond the phenomena
7. Discrimination as a form of wise judging
8. Mnemosyne (which means memory in Greek) represents the internalized knowledge that awakens and drives human towards independence and the fulfillment of each one's potential.

Although there has been growing interest in the research of metacognition, we still lacking a solid theoretical grounding. In the present paper, we present the 8 layers X 8 pillars model of metacognition and propose relevant educational strategies.

2 The 8 layers of 8 pillars of metacognition

2.1 The layer of stimuli – Training the observer to pay attention and keep all channels of sensory influx available and in readiness

Understanding sensory processing system. The sensory system, the gateway to human intelligence, provides constant access and processability to the sensory stimuli [10] through a fundamental set of processes involved in transforming external and internal sensory events into both temporary and long-lasting neural representations [11]. Sensory awareness does not involve only the five senses, but it includes: the exteroception (awareness of the external world), the interoception (awareness of the inner world), and the proprioception (the awareness of motion) [10,12]. Sensory signals enter the perceptual and cognitive processing systems via encoding, a "top down" process which converts stimuli into representations and it is based mainly on spatial attention and visualization [13]

Self-evaluating the facilitators as well as the inhibitors of sensory processing. Neurological disorders, sensory impairment, age, fatigue, stress play a crucial role in sensory processing [14]. Attentional processes influence either positively or negatively. Specifically, too much stimuli reduce attentional *resources* and slow down the sensory processing. On the contrary selective and sustained attention accelerate processing [15]. In addition, distraction, limited inhibition control slows down sensory encoding whereas visual-spatial processes enhance the quality and the speed of encoding [11]. Iconic memory, a basic type of sensory memory, although it has a large *capacity*, its *duration* is very limited. If the *control procedures* are not mediated, the information will not pass to the short-term memory as well as the visuo-spatial sketchpad, which is of great importance in learning [16-17]. Any *delay* reduces accuracy and inevitably leads to information loss [17]. Expectations and goals of the observers can determine whether a stimulus will capture the observer's attention [13].

Emerging the observer of the external and internal environment. Attention allows the observer to detect stimuli [15]. Observation of the sensations requires alertness, vigilance so as to free the mind of extraneous thoughts and ruminations and keep all channels of sensory influx available and in readiness to receive and process the sensory input in accordance with the task or the goals to be achieved [18]. Any lack of self-observation leads to behaviors that betray hyper-responsiveness or hypo-responsiveness [12].

Regulating the physiological and sensory processes. People manage the cognitive processes that take part in detecting, filtering, inhibiting, registering, processing, responding and modulating sensory signals. Sensory processing disorder, autism, depression, anxiety, schizophrenia, obsessive compulsive disorder, eating disorders are but a small sample of the disorders which fail to self-regulate the aforementioned processes [12].

Adapting sensory processes. People should be able to self-observe, to self-regulate, to shift attention from automatic to controlled forms of sensory processing, to regulate fight-or-flight reactions, in other words to be flexible and adaptable so as to achieve their goals [11-12,19].

Recognizing the stimuli, the different sensory features as well as the changes in the visual field. Agents are bombarded by stimuli, not all of which are discernable and hence not all registered as data [20]**.** Individuals should use strategies, during this pattern recognition stage, for matching information in the sensory registers against the long-term store in order to identify the sensory features [17]. Dyslexia is characterized by a deficit in visuospatial attention which enables people to shed the spotlight of attention and recognize the objects [21].

Discerning between competing or similar stimuli. Attentional control plays a key role in sensory discrimination – the ability to make fine tuned perceptual judgments about visual, auditory and other sensory stimuli [22]. Specifically, filtering irrelevant stimuli and selecting between competing stimuli are the brain's way of controlling sensory input so as to take adaptive decisions [15, 17]. Attention allows one to identify the differences between similar stimuli [15].

Recollecting sensory information. Sensory memory requires recollection of how a stimulus looks, feels, sounds, etc. [23].

Useful strategies: Stimulating senses so as to enhance the ability to keep a balance between alertness and agitation**.** Choosing sensory stimulation interventions such as music, light therapy, animal-assisted therapy, acupressure, reflexology, massage and aromatherapy [24]. Mindfulness practices play a key role in filtering input to primary sensory neocortex and organizing the flow of sensory information in the brain [25]. Exposure to nature decreases glucose, mental fatigue and restores attention. Integrative body-mind training reduces stress hormones, lower anxiety and improves attention [26]. Training attention and observation of external reality, objects, and situations via all senses simultaneously, allowing the sensory memories contents to become data by the procedure of observation [25-26].

2.2 The Layer of Data – Training the un-reflected observer to recognize the objects, the patterns as well as the traces in memory

Understanding data processing. Sensory input consists of a series of raw and disconnected observations [27], indeed meaningless at first glance. Nevertheless, data is not sterile but carries encrypted information [20].

Self-evaluating the factors that affect data processing. Information in short-term memory is decaying at a rapid rate. Rehearsal increases the amount of time the information remains in short-term memory and gives coding and other storage processes time to operate [17].

Emerging the unreflected observer while noticing the processes of data synthesis. Self-observation keeps the representations active, accessible and processable. Because a large amount of stimuli enters the sensory register very quickly and then decays, the subjects should develop observing strategies in an attempt to transfer the selected portion of stimuli into the short-term memory [17].

Self-regulating the processes involved in data processing. Subjects regulate via decisions the control processes involved in coding and transit between short- and long-term memory. Regulation processes allow short-term memory to receive data

from sensory registers as well as from long-term memory. In addition, it enables short-term memory to transfer data to long-term memory [17].

Adaptation to the competing demands. The individual flexibly should divert his/her effort between rehearsal and various coding operations in order to strengthen the stored information and protect it from interference [17].

Recognizing the objects, the patterns as well as the traces in memory. Recognition relates to identifying patterns previously stored in the long-term memory [28]. Since long-term memory is extremely large, people should develop search strategies to identify the appropriate traces in memory [17].

Discerning between data. The input of new items causes an existing one in the buffer to be bumped out, excluding those in some way connected to the long-term memory. The subject decides via attention and other control strategies which items to select and keep active so as to maximize his/her performance [17].

Recollecting data from the long-term memory. Short term memory (STM) receives input both from sensory registers and long-term memory in an attempt to maximize performance. A sensory item cannot be entered into STM until a long term search and match identifies the equivalent image. Familiarity accelerates the search and the match process. In addition to familiarity, strong pre-existing associations already in long-term memory contribute to successful search, detection and retrieval of data. [17].

Useful Strategies: Using strategies that facilitate encoding such as rehearsal, chunking, grouping of information [17, 29]. Nutritional enhancers boost encoding, reduce fatigue and help cognitive capacities, such as attention and working memory to operate more effectively [30].

2.3 The layer of Information – Training the pre-reflective observer to keep low level visualizations active, processable and convertible

Understanding information processing system. The central "engine" processing information is located in the working memory [29]. Working memory keeps low level visualizations active, processable and convertible to higher order ones [13, 31]. According to Baddeley's model [32], the central executive, the metacognitive component of working memory is capable of monitoring and controlling its own operations. Nevertheless, the real supervisor of this network is attention, the control system that constantly monitors, manages, directs and regulates the processes according to the external demands and the internal goals [16,33]. Executive attention gives people entry to the conscious state enabling them to gain awareness about their voluntary ability to control their own mental processes [33-34].

Self-evaluating the inhibitors and the facilitators of information processing. The attentional requirements of the tasks determine the individual's attentional efforts [14]. In addition, different people may have invariable attentional resources due to factors such as age, health, experience, anxiety and fatigue. Overflow impairs processing by narrowing the span of attentional control [29]. Personal goals, intentions and motivations tend to accelerate or slow down attentional efforts. Information outside the attentional spotlight can be processed only superficially. Without focus, information is not processed. Active processing requires active inhibition [14]. Short-

attention span and as a consequence high levels of distractibility are associated with low working memory capacity which in turn explains the poor performance in key learning areas such as reading and mathematics [35].

Emerging the pre-reflective observer while noticing the way information is processed. The pre-reflective aspect of oneself corresponds to the personal pronoun "I", to a sense of being the immediate subject of experience [36].

Regulating information processing in service of goal directed behavior [22]. Regulation of the streams of information is necessary. The subject must decide whether the available resources permit a parallel processing. If necessary, the tasks should be prioritized and performed sequentially. Regulation also aims at balancing the direction and focus of attention on task relevant information [14].

Adaptation requires flexibility to alternate the focus of attention between different tasks or resources of information [14].

Recognizing the most important information relevant to ongoing goals [15]. Working memory receives an overload of information some of which is relevant and some of which irrelevant. The subject should be able to filter information in favor of the most vital [15, 29].

Discerning the contents within the working memory. The observer selects information he/she will hold in working memory and removes no longer relevant information so as to avoid clutter [37].

Recollecting previously acquired information. Attention determines how well, fast and accurately the target information is processed and whether the information will be recalled [15].

Useful strategies: Training new skills, using mnemonic strategies [30]. Elaborating both during encoding and retrieval. Using a wide range of knowledge and senses to make a memory as vivid as possible, yet also connected to prior knowledge. Considering how the hippocampus uses spatial properties to learn, by using the method of loci [38]. Computer training enhances visual skills, such as visuo-spatial attention, cognitive flexibility and working memory [30].

2.4 The layer of Knowledge – Training the reflective observer to organize information into meaningful units

Understanding knowledge processing system. Knowledge is information that has been taken to a higher level of processing and given meaning. Knowledge emerges from analysis, reflection upon, and synthesis of information [27]. Well-structured knowledge allows us to quickly understand the world around us and make conscious decisions to control behavior. Knowledge structures aid memory encoding and consolidation of new experiences so we cannot only remember the past, but also guide behavior in the present and predict the future [38].

Self-evaluating the facilitators and inhibitors of knowledge acquisition. Memories are stored in long-term memory by meaning. Semantic memory is the part of the long term memory that allows us to acquire conceptual knowledge, in other words, to understand concepts, principles, theories, models and classifications [16]. According to Craik at al. [39] the more deeply an item is encoded, the more meaning it has and

the better it is remembered. Elaborative rehearsal, which differs from simply repeating, encodes information in more meaningful ways. Very strong schemas can lead to unwanted side effects such as false memories and misconceptions [38].

Emerging the reflective observer while noticing the way knowledge is constructed. The reflective self takes on a third-person perspective. The individual recognizes oneself both as the subject and the object of experience [40]. In other words, individuals are reflectively aware of having a perspective. In this level, a subjective feeling of identity emerges. Internal attention as a form of reflection [15] possibly supports this demanding process [37]. Third-person perspective is a process of reconstruction characterized by visualization of a remembered scene including oneself from the perspective of the observer. During this process, the observer possibly gets access to the representations in working memory [36].

Regulating the control processes and the mental abilities involved in knowledge acquisition and organization. The control processes are strategies that facilitate the acquisition, retention and retrieval of knowledge such as rehearsal, coding, and imaging [17].

Adapting the processes involved in knowledge construction. People, considering the processes underlying encoding, reactivation, consolidation and integration of knowledge should flexibly adapt existing schemas to new knowledge building demands [38].

Recognizing one's own knowledge and understanding. Knowledge in the individual's mind is characterized by the justifiable belief that he/she knows that something is true or it appears to be true [27]. *This stage* is more concerned with pattern recognition and extraction of meaning [39].

Discerning between what one knows from what he/she does not understand. Discrimination requires the ability to identify what is valid, significant and relevant [27].

Recollecting previously acquired conceptual knowledge, learned rules and past experiences. Thanks to schemas, one constructs new memories or making the better connected by filling in holes within existing memories and interpreting meaning based on past memories. Culture influences one's schemas and thus can affect how we remember and what we know [41].

Useful strategies: Reactivating prior knowledge when one learns new information, applying retrieval strategies and finding links between newly learned information and existing knowledge [38]. Retrieval practice incites meaningful learning. Equally important, sleep enhances knowledge consolidation [30].

2.5 The layer of Expertise – Training the strategic observer to be fast, flexible, decisive & visionary

Understanding Expertise. Experts are aware of their ability to understand information. They have well-organized interconnected units of knowledge and have automatized steps within problem-solving strategies. Experts develop sophisticated representations of problems. They recognize the unknown and predict the degree of difficulty in problems. Expertise requires also high speed and accuracy in reaching

appropriate solutions [42]. The true experts develop higher order social and emotional skills [43].

Self-evaluating the inhibitors and facilitators to expertise. Expertise needs good information processing and good strategy use. Experts possess superior short-term capacity and extensive knowledge in the long term memory. Thereby, some aspects of information processing become automatic with experience and systematic practice allowing short-term memory to do other things simultaneously [44]. Working memory and specifically its supervisory attention system overcomes the boundaries of automaticity, proposes novel behavioral solutions and weighs options before deciding a response [16]. Incredibly complex tasks become almost second nature after repeated practice [14] because of procedural memory, the implicit part of the long term memory [16]. On the contrary, low working memory is associated with difficulties in making visual representations, transferring strategies from one area of learning to another, to monitor more complex tasks [35]. Strong emotions [42], negative beliefs, stereotyping are considered additional obstacles to expertise. Even experienced and skilled performers fail under uncontrollable stress and excessive self-focus [16, 29]. However, when stress directs attention toward processes involved in the execution of the skill, one expects a top performance. Positivity and motivation facilitate the flexibility of attention improving the way one thinks, performs multiple tasks and solves problems creatively [45].

Emerging the Strategic Observer who notices the processes of interconnection of knowledge in cognitive and socio-emotional level. Social observers reflect on their behaviors. This process requires the discernment between the self as the subject and the self as the object that is known [43]. In a higher level, reflective observers can recognize also the cause of a mental or emotional state [36]. Experts are carefully monitoring their own problem solving strategies and processes [42]. In complex tasks, they monitor the multiple sources of information [14]. In general, in this level of observation, the sense of self depends more on complex cognitive processing and less on emotional and affective operations [36].

Self-regulating failures in cognitive as well as socio-emotional level. Taking immediate decisions and altering strategies and plans are a form of self-regulation [44]. Self-regulation in expertize depends mainly on top-down control processes, which means that the current goals must determine what individuals focus on. Executive attention directs attention towards goals and plans, removes distractions and temptations and keeps attention active on relevant information [37]. In social level, people should be able to suppress automatic associations with stereotyped social behavior by regulating the way they process social information [29].

Adapting to various situational demands either cognitive or socio-emotional to extract the best possible outcome. Experts consider alternatives to events, conceive what others think, shift perspectives, mindsets and behavioral repertoires and imagine themselves in situations which haven't taken place yet [36, 46].

Recognizing the patterns of knowledge, the actions' intentionality and the biased social judgements. Experts recognize the need for metacognitive strategy use [44]. Entrepreneurs identify patterns of knowledge acquired through experience so as to perceive connections between seemingly unrelated events [47]. In social level,

experts recognize both their own as well as others' mental and emotional states. Recognition enables one to empathize, to accept others evaluations and most important to predict behaviors [43].

Discerning between alternative plans, strategies and behaviors [42]. Experts cope with complexity by getting rid of those elements that are superfluous or redundant. Professional work relies on the selection of relevant issues and the omission of the irrelevant ones [29].

Recollecting relational knowledge consciously. The declarative memory permits conscious recollection of facts, events, meanings and behaviors, whereas the non declarative encodes sequences and permits one to develop skills such as motor skills [13].

Useful strategies: Focusing on repeated practice and experience [16]. Familiarization and task simplification turn a chaotic situation into a better structured. Mnemonic techniques facilitate memory retrieval, which in turn supports problem-solving and decision making. Alternating between verbal with visual code, using metaphorical language [29], obtaining practical skills and being creative, pursuing paths of inquiry that the others ignore or dread [42]. Remembering to work in teams, obeying the rules of cooperation to overcome individual limitations (i.e. overflow) and increasing productivity [29].

2.6 The layer of Self- Actualization – Training the "real you"-observer to realize hidden competencies and real motives, think creatively and solve problems of meaning

Understanding Self-actualization. Self-actualization refers to the realization of the individual's potentialities. Self-actualization needs self-awareness, intrinsic motivation, originality, intuition, optimal experience and expansion of understanding [48].

Self-evaluating the inhibitors and facilitators. Conflicting thoughts and dysfunctional emotions, cognitive/psychosocial schemes, defense mechanisms, a mind crowded with content often imposed by external situations, expectations, wishes, obligations are just some of the obstacles. Over-learned dysfunctional structures and social stereotypes disrupt the appraisal of here-and-now reality [40]. Supportive learning environments play a major role in cultivating an early tendency toward self-actualization [48].

Discovering the "real you" observer. Self-actualizers desire to explore and enlarge experiences, seek meaning in life in order to expand the sense of self [46].

Self-regulating defense mechanisms and adopting adaptive coping strategies. Self-actualizers deal with the society pressures and cope with self-incongruities so as to become fully functioning persons [49].

Adapting to new knowledge and experiences. To be flexible, a person needs to be open, receptive and curious so as to avoid rigidity, reliance on stereotypes, conformity and dogmatism. Self-actualizers are ready to modify their beliefs about their own self [46].

Recognizing the hidden competencies, the real motives, the higher needs. Self-actualizers have the capacity to appreciate the basic goods of life with awe, pleasure and wonder [50].

Discerning between moral and immoral decisions. Self-actualizers make ethical decisions due to their ability to discern right from wrong [50].

Recollecting information with reference to self-identity. Episodic retrieval of autobiographical events contributes to the realization of one's own identity [43].

Useful strategies: Learning experiences that facilitate creativity, deep understanding of new concepts, acceptance of failure and the intrinsic motivation to move onward. Reflective technologies, artificial intelligence and human-computer learning systems can be instrumental in developing metacognitive abilities required for self-actualization [48]. Cultivating and developing the need to know your real self, your true abilities and your true potential. Training new abilities of visualization, reaction speed, mental flexibility, creativity and new ways of perception. Training to see multiple dimensions in each situation, multiple interpretations and usabilities of the same object [26,48].

2.7 The layer of universal knowledge –Training the rational observer to "see" the global laws as the real substructure beyond phenomena

Understanding the underlying unity of knowledge. Scientists develop autonomous "knowledge domains", each having their own methods, assumptions, data and models. However, despite the differences, all these sectors develop their knowledge domains in similar ways. The world as we experience it, appears to have a kind of unity. Beyond the phenomena of the experienced world, there is an intelligibly organized reality. Everything exists interdependently [51]. According to Niels Bohr individuality is related to indivisibility and therefore to wholeness [52].

Self-evaluating the inhibitors and facilitators towards universal knowledge. All knowledge is represented within a conceptual framework adapted to account for previous experience. However, any such framework may prove too narrow to comprehend new experiences, to find a "common" language to interpret the different observations [52]. Wisdom processing systems, like the human cognitive system, have much more processing power, storage and network capabilities and consist of a group of powerful expert systems connected together so as to exchange information in an attempt to make predictions, make critical decisions and solve complex problems [53].

Revealing the Rational Observer. The Ultimate Reality becomes conscious of Itself in human reason [54]. The rational observer does not trust subjective observations but focus on objective scientific findings [55]. Reasoning would not be possible without high working memory [56].

Self-regulating cognitive biases, **false beliefs and fallacious reasoning**. Self-regulation depends on human ability to prevent subjective observations and personal bias when tending to prioritize over objective scientific findings. Self-regulation demands constant self-observation and self-evaluation so as to accurately assess the world [55].

Adapting to the multiple dimensions of reality. Being flexible to develop superior creativity in an attempt to see connections between seemingly unrelated things and pull apart elements from an integrated whole [56].

Recognizing the hidden dimensions of reality, the unity of knowledge as well as the universality of emotions. The quest for the interpretation of the human nature as well as the reality is reflected in Philosophy, Psychology, Science and Religion [54]. Respectable scientists such Einstein and Minkowski as well as Nobel Laureates developed universal theories identifying hidden dimensions of reality [57]. Many scientists recognize consciousness as the building block of nature that is present at all levels of the fabric of reality [58].

Distinguishing subjective from objective knowledge, meaningful from meaningless theories [27, 57]. Scientists seek to discern between the interpretations of reality and the absolute knowledge of reality itself [54].

Recollecting superior patterns. Superior pattern recognition constitutes the basis of intelligenc**e** and permits human to reason, create symbols and produce new images of the world in the absence of significant sensory input [59].

Useful strategies: Training visualization and scientific thinking skills (e.g., evidence-based research, group discussions, evaluations of arguments) including open-mindness, inquitiveness, the ability to test claims, data and theories, to analyze, to interpret and to be informed consumer of information distinguishing good from bad information. Courses and educational programs promoting scientific thinking adapted for each grade level may provide students with the foundation of solid scientific thinking skills and allow expansion of scientific thinking into other scholastic areas and classes [13, 55]. Training the mind to see that everything is connected and interrelated. Training to see the global laws as the real substructure beyond phenomena [60].

2.8 The layer of transcendence - Training the mindful observer to be present in deep silence fused with the vibrations of the Universe

Understanding the concept of transcendence. Transcendence means breaking the barriers of self-limitations. The subject transcends self-focus needs and motivations and reaches the highest forms of emotional intelligence developing self-transcendent positive emotions like elevation, compassion, admiration, gratitude, love and awe [60]. Transcendence usually emerges in life hardships like poverty, in failures, in unwanted circumstances that one cannot avoid or resolve like illness, ageing or loss. Transcendence could be compared with a state of sleep during which consciousness itself is kept alert, in a state of high arousal and awareness of external sensorial stimulation [40].

Self-evaluating the inhibitors and the facilitators of self-transcendence. Our limited minds, being individual parts of the cosmic consciousness, operate in time-space energy constraints and inner conditioning that only partly can reflect the true nature of reality [58].

Being the Mindful Observer. Mindful observer represents a dynamic totality, the silent witness. The subject and the objects are fused into one [40]. Attention operates without effort [61]. In mental states of decreased self-salience and increased feelings of connectedness, the subjective sense of one's self as an isolated entity can temporarily fade. In other words, one transcends the sense of self [60, 62].

Self-regulatory processes involve decentering, attentional broadening, reappraisal and savoring. Human takes distance from self-referential appraisals shifting attention from egocentric to universe-centric processing, towards larger entities [62].

Adaptation requires openness to experience of deep silence. To be flexible, a person needs to be receptive, curious and open. Openness and experience of silence cultivates wisdom as well as an attitude of tolerance and compassion [46].

Recognizing some inexpressible truth communicated by a higher intelligence [63]. Recognizing that each situation is different from any other and at the same time driven from same source, increases compassionate style of communication [46].

Discriminating the Self across time and the Self in the present moment, here and now [36,75].

Recollecting the Metacognitive Charioteer, the real holistic total Self. In the Republic, Plato the Greek philosopher describes the tripartite structure of the psyche, namely the rational part, the emotional and the vegetative. He explains his idea with an allegory according to which a Charioteer, who represents the rational part of the soul, drives a chariot pulled by two winged horses. The Charioteer directs the entire chariot/soul, trying to stop the horses from going different ways, and to proceed towards enlightenment [64]. According to Chun et al. [15], external and internal attention are on opposite ends of an axis, of a continuum which is under the law of the goal-directed attention. According to Drigas et al. [7] metacognitive procedures, in one word consciousness is the axis that supports the ladder of human intelligence. In the level of Mnemosyne [9], human becomes the metacognitive charioteer who bridles the two winged horses such as the internal and external attention.

Useful strategies: Spiritual exercises, meditation practices, enlightened mentors can help one to ascend the road of transcendence dealing with disturbing emotions, unwanted automatisms, dysfunctional schemes and defense mechanisms that come from past life and prevent spiritual growth [40]. Mindfulness intervention, prayer practices as well as brain stimulation could be used to reach more profound states of consciousness [60]. Training Presence, silence, astonishment & fulfillment as the main traits of Transcendence. Training to see and feel that everything is One. Knowing that everything is really motivated by seeking Knowledge of the Self & Universe, Consciousness and Happiness [60, 75].

3 Discussion

Although we emphasize the importance of self-regulation in order to move from the lower levels of existence to the higher, the value of self-observation tends to be even more important. Self-observation makes us conscious. In an attempt to perceive the observing self, a different more conscious observer emerges. This is an ongoing process [65]. In philosophy, this form of metacognition corresponds to the recollection of past moments of consciousness, recalling both the perceived events and oneself perceiving that event [36]. At first sight, such an infinitive process does not explain anything about self-observation [65]. However, such a finding may be of great importance as it seems to be in line with what cybernetics underline; that the sense of

self, as well as the sense of reality is just a construction. In other words, we create our own reality [66].

Metacognition is an open-ended activity; as the cognitive system grows up or evolves, the observer expands its description about its own cognitive system [66]. The evolution of cybernetics seems to be aligned with the above statement. First-order cybernetics focuses on the "observable systems", in which an external observer emerges (subject-object paradigm). Second-order cybernetics signals the transition to the "observing systems", in which an internal observer is embedded in the object of observation (subject-subject paradigm). Second-order cybernetics depends on reflection. Third-order cybernetics refers to self-developing systems in which the subject is a "self-developing poly-subject environment" (subject-metasubject paradigm). Third-order cybernetics depends on interpretation [67]. The fourth-order cybernetics seeks self-consciousness, rationality, universality, coherence, order, balance and harmony as measures of the observer [68].

The transition to higher levels of observation brings about new types of control [67]. In human cognition, control can be viewed in terms of a set of executive attentional processes [15, 37]. Attention is the core property of all perceptual and cognitive operations [15]. Attention enables us to observe both the cognitive processes as well as the process of observation [37]. *Indeed, attention participates in processes like selection, filtering, inhibition, processing, storage, retrieval, prediction, monitoring, regulation, adaptation, recognition, discrimination, recollection and transformation of knowledge. According to the new layered model of metacognition, each level describes a higher-order control system which operates under the rule of the aforementioned attentional processes at an ever more refined/abstract level. The layered model of Metacognition, in its deep structure, could be seen as layered model of meta-attention. Attention is omnipresent in every component of metacognition, in each stage of metacognitive development.*

Although, attention has a variety of resource pools shared across multiple systems [15], attention is mainly driven by consciousness [69]. What we pay attention determines the content of our consciousness [46]. The central executive, which is tightly linked to attentional control processes [16], in other words internal attention, is closest to human consciousness [70]. It is not accidental that heightened states of attention regulate mental operations involved in higher order cognition and contribute to altered states of consciousness [71].

Another key point of discussion includes the factors that either accelerate or slow down the metacognitive development. Extensive literature has already documented the deleterious effects of heavy metal toxins on the human brain and nervous system. Lead and mercury exposure, airborne and organic chemical pollutants have a potential damage to brain functioning. Air pollution can significantly affect the developing nervous systems of children as well as the mature nervous systems of adults. Organic chemical pollutants such as PCBs and dioxins are also increasingly viewed as emerging threats due to their prolonged persistence in the environment and ability to accumulate in food chains [72]. For the above reasons, one major pillar of metacognition is about learning about the inhibitors and facilitators of metacognitive development. By learning about the risk factors, we gain the advantage to understand the im-

portance of the factors that affect our cognitive and metacognitive abilities and predict learning and other difficulties.

Dietary factors have an important impact on fundamental cognitive and emotional processes. Specifically, dietary factors influence molecular systems and mechanisms which in turn have a major impact on neuronal function and synaptic plasticity. Gut hormones or other hormones produced in the brain itself can influence our mental abilities. Understanding the molecular basis of the effects of food on cognition will help us to determine the best way to manipulate diet in order to increase resistance of neurons to insults and promote mental fitness [73].

The layered model of metacognition could be adopted to formulate a unified education policy, since it provides a holistic proposal that can cover the needs of all levels and forms of education. It is totally inclusive since it adjusts to the needs of 21st century education and the special needs of each learner regardless of the mental level, age, educational level, profession or the origin. The learner, according to our approach, is treated as a combination of physical, cognitive, emotional and spiritual needs which gradually advance. Education in the 21st century is called upon to both encourage individuals' gifts and self-actualizing needs and prepare students to enter in a high-consciousness society [76].

4 Conclusions

Through this study, we presented the new layered model of metacognition in terms of consciousness. In accordance with our approach, metacognition is composed of eight constituents structured in eight interconnected stages of consciousness plus supporting each one of the eight intelligences of Gardner's theory (Figure 1,2) [7,9, 74]. On the basis of our model, the core metacognitive components such as self-observation, self-regulation, flexibility, recognition, discrimination and recollection are considered as multi-layered and not at any rate one dimensional. The same applies to the cognitive processes and abilities such as attention, memory, perception, and pattern recognition. At each higher level, they display more advanced or refined attributes and functions responding to the necessity of creating more abstract mental representations and upper class motivations, thoughts and emotions.

Ascending from lower to higher levels of metacognition entails moving to advanced forms of self-awareness, higher levels of self-observation which in turn assumes ever higher control systems. Each layer of metacognition describes a higher-order control system which operates under the rule of a series of attention processes at an ever more refined, abstract, united level. Similarly, the sense of self, as a necessary mental construction, is multi-layered too and follows the uphill road that gradually disembodies multiplicity and reveals unity. The layered model of metacognition does not merely aim at presenting an alternative approach but seeks to clarify that metacognition goes through strictly defined stages of development. We come to the conclusion that it is essential to create appropriate metacognitive learning environments based on the systematic training of each particular metacognitive level.

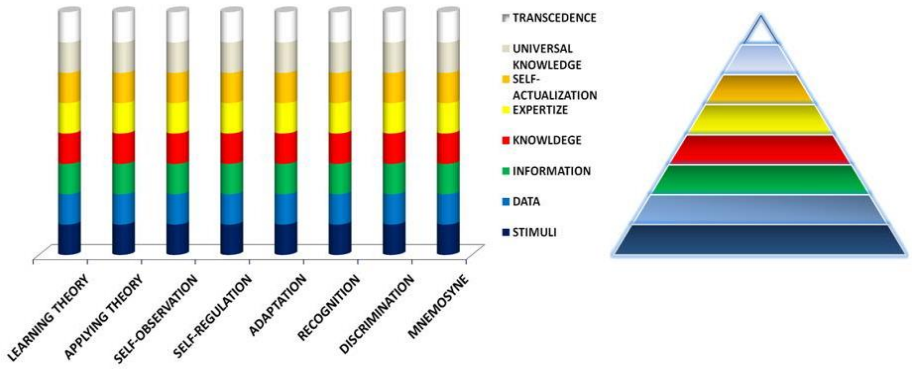

Fig. 1. The layered model of metacognition is composed of eight pillars structured in eight interconnected stages.

Fig. 2. The new layered model of Metacognition stands on 8 Intelligences X 8 Pillars X 8 layers of Consciousness.

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