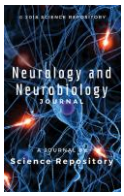

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Review Article

An 8-Layer Model for Metacognitive Skills in Kindergarten

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ARTICLE INFO

Article history:
Received: 8 January, 2021
Accepted: 26 January, 2021
Published: 9 March, 2021

Keywords:
Metacognitive skills
kindergarten
8-layer model

ABSTRACT

In recent years, more and more researchers have been investigating cognitive and metacognitive skills that seem to be related to the improvement of the performance of kindergarten children. In this paper, we present the cognitive processes that are related to it, such as working memory, attention, inhibitory control, executive function, and processing speed. In addition, we refer to metacognitive skills and their role in controlling and regulating cognitive processes in order to improve children's performance. Finally, we present a new taxonomy of skills, the pyramid of 8 levels, as well as their gradual development through the appropriate cognitive and metacognitive mechanisms. In this study, a holistic and multi-disciplinary approach is attempted by collecting and utilizing data from sciences such as cognitive psychology, neuropsychology, and philosophy. The research has led us to the 8 layers that underpin metacognition in preschoolers following the model of the hierarchical organization of knowledge.

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Introduction

Early research suggests that metacognitive ability is not found in young children. Since Piaget's early work and even from more recent research, young children have been considered as having little or no awareness of their mental activity. Traditionally, there was a belief of a general lack of awareness, preschoolers show little understanding of cognitive cueing [1]. Young children did not appear to understand that mental events trigger other mental events, usually in a coherent manner related to one's experiences. Moreover, Piaget's early studies suggested that young children are basically incapable of introspection and that they tend to acquire this metacognitive awareness gradually during elementary-school years. According to Piaget's early conclusions, up to the age of 7, introspection seems to be completely absent, and from 7 to 12 there is a consistent effort to become more and more conscious of themselves [2].

When looking at the word 'metacognition', it seems to be a very complicated concept, so people expect that this ability is too advanced for young children. However, increasing evidence shows later that much of the historical research seriously under-estimated the metacognitive abilities of young children. Istomina's research showed that in a meaningful environment and with enough scaffolding from teachers, children are able to understand the purpose of remembering and forgetting [3]. As a result, there is increasing evidence showing that children who are provided enough time to work on tasks are taught in a meaningful environment and have proper facilitations do show metacognition [3].

In the light of the above, educators have long been interested in children's knowledge and control of their own cognitive activities [4]. Within the literacy community, there is growing interest in developing clearer conceptions of metacognition and its role in children's construction of meaning [5]. The National Educational Panel Study (NEPS) aims at assessing competencies that are considered to be of particular importance for educational pathways and participation in society. In addition to longitudinal measurements of reading, comprehension, mathematical competence, and scientific literacy, metacognition, are part of the assessment programme. Metacognition is considered a central component in the process of self-regulated learning and is defined as any knowledge or cognitive activity that takes as its cognitive object or that regulates any aspect of any cognitive activity [6].

Accordingly, studies involving younger children generally show that the acquisition of metacognitive knowledge begins as early as in

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http://dx.doi.org/10.31487/j.NNB.2021.01.01

kindergarten. Children from the age of four years onwards seem to have at least some basic understanding of memory and learning processes. For instance, they begin to understand that they can forget things, that it is harder to remember more items compared with only a few items, and that additional study time may be helpful [7]. Generally speaking, young children begin to appreciate the active role of the mind in learning and remembering. Once children enter school, their metacognitive knowledge-especially their knowledge about the importance of task characteristics and memory strategies-increases rapidly [7].

As a result, educational psychologists, educators, and specialists analyse and study the role of cognitive and metacognitive skills in the preschooler's education, learning and their professional life. However, there is scope for further research in order to investigate the importance, the models of metacognitive development over time as well as the teaching methods that may assess metacognition in school settings. In this paper, we are going to propose a cognitive-based approach of an 8-layer model (pyramid) of metacognitive skills in preschoolers, according to the 8-layer model of the consciousness and intelligence knowledge pyramid, which adapts the different types of them and we define the cognitive as well the metacognitive components that may help preschoolers to move from one layer to the other and finally reach the top of the proposed pyramid [8].

Finally, in this study, a holistic and multi-disciplinary approach is attempted by collecting and utilizing data from sciences such as cognitive psychology and neuropsychology, and philosophy. The research has led us to the 8 layers that underpin metacognition, which follow the model of the hierarchical organization of knowledge. According to this approach, cognitive and metacognitive skills evolve progressively depending on the effort an individual exerts. It is worth noting that some cognitive functions such as attention and working memory seem to surpass the rest, since they operate simultaneously as cognitive and metacognitive abilities, affecting the functioning of the layers, other cognitive functions, and in particular, the higher mental abilities [8].

Aims and Methodology

This research does not seek to simply represent what has been written for cognitive and metacognitive knowledge as a typical review. Instead, our research is based on the exploratory literature of the most popular published articles and book chapters in the field of Cognitive and metacognitive Knowledge in kindergarten children, as we summarize what specialists, researchers, psychologists, and educators believe about cognition and metacognition in kindergarten education in order to investigate:

i. The cognitive and metacognitive knowledge in theory.
ii. The main cognitive factors that are assessed in kindergarten education and may affect or predict metacognitive awareness as well as the progressive development of metacognitive skills.
iii. What is the role of metacognition in the development of kindergarteners' learning. Based on the findings arising from the investigation of the objectives above, we propose a new taxonomy of cognitive skills, forming the Pyramid of cognitive and metacognitive skills, a cumulative hierarchical framework of eight layers, indicating at the same time the cognitive procedures, as well as the metacognitive skills required for the individual to 'ascend' to the next layer of the pyramid.

Research Findings

I Cognitive and Metacognitive Knowledge in Theory

According to Piaget's interpretation, the process of learning and the acquisition of knowledge are based on the evolution of intelligence. In his effort to analyse the psycho-spiritual development of children and adolescents, Piaget (1936) presented the Developmental Stage Theory. Piaget's theory of cognitive development consists of four stages, each building on the previous: Sensorimotor Stage (0-2 years), where children learn how to coordinate sensory data and motor skills in order to understand their environment, Preoperational Stage (2-6 years) where children present symbolic thinking without cognitive processes, Concrete Operational Stage (7-12 years) during which there are signs of verbal understanding and logical reasoning, and Formal Operational Stage (12 years and above) where adolescents present abstract reasoning [9].

Furthermore, Benjamin Bloom created a taxonomy with six levels of cognitive skills: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation, suggesting that teachers should guide students so that they move up the taxonomy of learning objectives as they progress in their abstract reasoning [10]. Also, Anderson & Krathwohl proposed the Revised Bloom's Taxonomy, an update of the original one-dimensional Taxonomy to two dimensions – the Knowledge Dimension (factual, conceptual, procedural, metacognitive) and the Cognitive Process Dimension (remember, understand, apply, analyse, evaluate, create) [11]. In 1982, Biggs & Collis presented the SOLO Taxonomy (Structure of the Observed Learning Outcome), an instructional/evaluative tool that could be used by educators to evaluate learning quality in various subject areas [12]. The SOLO Taxonomy describes five different levels of understanding: i. Pre-Structural Level, ii. Uni-Structural Level, iii. Multi-Structural Level, iv. Relational Level and v. Extended Abstract Level. The teacher can adapt the idea of the Taxonomy to his /her specific classroom needs and differentiate the instruction as well as the evaluation, to optimize learning outcomes. Gagné (1970) approached knowledge selectively and tried to classify the theories of knowledge hierarchically. His taxonomy is actually a classification of learning consisting of five types: Intellectual Skills, Cognitive Strategy, Verbal Information, Attitude, and Motor Skills. According to Gagné, each of these five learning outcomes requires a different kind of instruction [13]. Ackoff (1989), in his article From Data to Wisdom proposed a model (wisdom hierarchy) including the following levels: Data-Information-Knowledge-Understanding-Wisdom. His model could be considered as a pyramid as each level includes the previous levels. According to Ackoff, wisdom is the ability to increase effectiveness, while intelligence is the ability to increase efficiency [14].

According to the above statements, children's success in the early school years is associated with a range of developmental outcomes. Low levels of achievement in the first few years of school predict continued academic problems with the appearance of lifelong employment difficulties and mental health problems. Prior research on early academic

success has emphasized cognitive precursors, especially processes associated with metacognition, and other skills such as working memory. According to Duncan and his colleagues (2007), kindergarten achievement is important for later success, and the cognitive skills that are supported at this age are thought more important than other skills [15].

Research has repeatedly shown that executive functioning contributes to early school success [16]. Executive functioning is the product of a complex cognitive regulatory system that helps guide behaviour in a goal-directed manner. Executive functioning encompasses a range of processes, including inhibition (the ability to refrain from performing an action), working memory (the ability to hold information in mind in order to complete a task), the ability to shift attention between two competing tasks, and the emotion regulation (the ability to monitor and respond to changes in emotional state). Executive functioning is critical for school readiness because schools require children to control impulses, follow directions, transition smoothly between activities, and focus attention on relevant task information. Research has shown that executive functioning skills develop rapidly during the first 5 years of life. These skills have been shown to enhance children's ability to engage in effective goal-directed behaviour in the school years and give them the appropriate metacognitive skills that will help them to succeed [17].

Furthermore, before talking about metacognitive awareness, we should first try to define the notion of 'metacognition'. So, by definition, the term 'metacognition' refers to higher-order cognition about cognition, or 'thinking about one's thinking'. Metacognition refers to one's knowledge/awareness of his/her own cognitive processes or anything related to them and to the awareness of one's thinking [18]. The first researcher who gave a thorough description of metacognitive knowledge was John Flavell (1979). The first definition of metacognition was given by him who stated that metacognition comprises people's awareness regarding their own thinking as well as their ability to evaluate and regulate their thinking. From the beginning, Flavell's research interests focused on developmental psychology and, in particular, on children's thinking about their own thinking processes. Flavell's studies of children's thinking about their thinking processes were greatly influenced by the work of Jean Piaget, who has been of great significance to developmental psychology. It also required a new word to indicate that thinking about thinking is ranked at a higher level than thinking itself [4]. Specifically, on the basis of the work of Piaget, Flavell described children's development of formal operations as thinking about thinking itself rather than about objects of thinking.

Moreover, the term 'metacognition' is classified into three components according to Flavell (1979): the metacognitive knowledge (what individuals know about themselves and others as cognitive processors), the metacognitive regulation (the regulation of cognition and learning experiences through a set of activities that help people control their learning and their cognitive processes) and the metacognitive experiences (the experiences that have something to do with the awareness of current, on-going cognitive endeavor). This very broad conceptualization includes two components, namely declarative and procedural metacognition. While the declarative component refers to people's knowledge about memory, comprehension, and learning processes, the procedural component comprises executive skills related to monitoring and self-regulation of one's own cognitive activities [19].

According to Flavell and Wellman (1977), declarative metacognition refers to conscious, explicit knowledge about person-, task-, and strategy variables. Thus, it includes knowledge about the strengths and weaknesses of one's own memory and learning, knowledge about task characteristics as well as knowledge about ways and means of attaining cognitive learning and achievement goals. Procedural knowledge describes how a strategy effectively works, and conditional knowledge helps us understand which strategies are useful for solving a certain task. Whereas declarative and procedural knowledge about strategies can be considered prerequisites for strategic learning, conditional knowledge additionally enables the learner to choose an adequate strategy in a given situation and to be responsive to changing circumstances. The importance of declarative metacognition in the educational context has been documented in many studies [20]. Although Flavell laid the foundations of metacognition, Brown's theoretical framework for metacognition constituted the basis for many researchers and is considered as one of the most fundamental frameworks of research on metacognition [21].

Brown suggests that metacognition consists of two components: a) knowledge of cognition and b) regulation of cognition. Knowledge of cognition refers to the relatively stable information that learners have regarding their cognitive functions. It includes individuals' knowledge concerning how they store and retrieve information, how and why they implement specific strategies, and how they perceive themselves as problem solvers [22]. Knowledge of cognition can be summed up in three components: declarative, procedural, and conditional knowledge. Declarative knowledge is the awareness of the strategies and/or concepts that are important in relation to a particular task. Procedural knowledge contains information about the way individuals perform cognitive activities, while conditional knowledge contains information about when the individuals will implement certain knowledge and strategies. On the other hand, regulation of cognition refers to the dynamic aspects of the transformation of knowledge into action and requires individuals to control the progress of their work and then revise or modify their strategies based on the results of their work. This allows learners to adjust to the changing demands of a task, adapting to the specific conditions that occur during its implementation. Regulation of cognition consists of three individual processes: a) planning, b) monitoring, and c) evaluation. Specifically, it includes the planning of actions before the execution of the task, the monitoring of actions during the execution of the task, and the evaluation of the results of the actions after the completion of the task. These processes are not fixed, but they depend on the persons' familiarity with a task, their motives, and preferences [23].

Finally, metacognition has gained interest in educational research as several researchers have argued that it may contribute to the improvement of the learning processes since it makes the learners capable of adapting their knowledge, choosing the right strategies, controlling the course of their work, distributing their time accordingly and regulating their performance [24]. Furthermore, metacognition appears to be linked to the development of experience, self-awareness, and critical thinking. In addition, metacognition was found to comprise

a very powerful predictor of learning performance. The relationship between metacognition and performance could be attributed to the fact that metacognition relates to students' ability to adapt knowledge and strategies and regulate their own learning. Learners, who are able to effectively discern what they know and what they do not, are more likely to focus on learning new information rather than dealing with information that they already possess [25].

II Cognitive Factors in Kindergarten Education

Cognitive development has to do with learning and thinking, including asking questions, developing an increased attention span, visual discrimination, matching (Link1), comparing, sorting (Link2), organizing, understanding fact and fiction, understanding cause and effect, and simple reasoning. Preschoolers are full of questions, and they love to collect things. Preschoolers also like to practice the same thing again and again and love hearing the same story (Link3) told multiple times. They love taking risks and trying new things while these efforts develop their cognitive abilities. Whether in formal schooling or playing at home (Link4), these characteristics should be embraced and encouraged.

Cognitive skills are understood as the mental actions or processes of acquiring knowledge and understanding through thought, experience, and the senses. Executive functions are described as higher-order cognitive skills that enable self-control and include response inhibition – described as the suppression of actions that are no longer required, or that are inappropriate, planning – described as a plan that can be represented as a hierarchy of sub goals, attention – which is described as the ability to attend to some things while ignoring others, and working memory – described as the ability to store and manipulate information over a period of seconds to minutes. Visual processing is described as a path that information taken from visual sensors to cognitive processing. Short-term memory is described as the capacity to hold information in mind in the absence of external stimulation over a short period of time. Information retained for a significant time is referred to as long-term memory. Fluid intelligence is the ability to think logically and solve problems in novel situations; this is independent of acquired knowledge. Crystallized intelligence refers to the capacity to use skills, knowledge, and experience by accessing information from long-term memory. Intelligence quotient (IQ) is a measure to calculate a person's intelligence. Academic skills are skills developed or measured in educational settings [26].

More specifically, working memory can be seen as a short-term ''working space'' for temporarily retaining information while the individual is involved in other tasks. Baddeley and Hitch (1974) described working memory as a three-way system comprising a central executive and two slave systems. The central executive can be seen as a limited-capacity processor responsible for attentional control over actions and for processing and coordinating the two slave systems called the phonological loop and the visuospatial sketchpad [27]. The distinctions between the central executive system and specific memory storage systems in some ways parallel the distinctions between working memory and short-term memory. Experimental tasks assessing working memory and the influence of the central executive component typically involve storage, processing, and effortful mental activity [28]. Most of the literature indicates that working memory enables the retrieval of knowledge stored in long-term memory and its mental manipulation and application to foster the interpretation of novel information and the solution of problems [29].

Moreover, processing speed can be considered as the efficiency and rapidity with which simple cognitive tasks are performed. For example, processing speed can determine how quickly numbers are recited, objects are counted, and problems are solved. The processing speed also affects the efficiency of working memory and short-term memory; the more quickly these systems work, the more information is processed before decay [30]. Developmental research also suggests that working memory and attention control undergo rapid development during the preschool years and have a substantial impact on children's development and corresponding academic achievement [31]. Much of this research has focused on the role that cognitive control capacities, often referred to as executive functions, play in fostering the child's capacity for self-regulated and goal-oriented learning. As a group, executive function skills, including working memory, attention set shifting, and inhibitory control, all show substantial development during the preschool years (ages 3-5). Conceptually, these skills enable children to organize their thinking and behaviour with increasing flexibility, decrease their reactive responding to contextual cues and contingencies, and engage in self-regulated and rule-governed behaviour. Developmental researchers have postulated that executive function skills, particularly working memory and attention control, thus facilitate school readiness and early learning by supporting behavioural self-regulatory capacities and social competence and by fostering children's capacities to engage more effectively with teachers and peers in classroom learning activities [32].

Attention control includes the capacity to focus and flexibly shift attention, as well as to ignore irrelevant stimuli and inhibit proponent responding to stimuli, in order to respond to task demands. Attention set shifting has shown unique associations with reading among students in elementary school. Research with students who have learning difficulties has revealed that many have trouble controlling their attention, focus and inhibiting irrelevant information; poor problem solvers remember less relevant and more irrelevant information than good problem solvers [33].

Finally, at least, the above three specific executive functions seem to contribute to children's early academic achievement and classroom behaviour: working memory, or the ability to hold and manipulate information during a brief time, cognitive flexibility, or the ability to shift attention among distinct but related aspects of a task as well as to adapt responses using new information and inhibitory control, or the ability to delay or inhibit some initial response while attempting to complete a task requiring goal-directed behaviour [34]. These three functions may contribute to academic achievement and behaviour by facilitating children's organization and self-regulation. Working memory may help children manage information maintenance and processing demands while avoiding information loss due to forgetfulness and distraction. Cognitive flexibility may help children attend to changing meaning in texts, incorporate additional knowledge, and simultaneously disregard or update previously used knowledge. Inhibitory control may help children ignore impulsive responses and remain engaged during classroom instruction and activities [35]. These

organizational and regulatory functions may be especially useful when completing a classroom's novel or demanding tasks.

III The Role of Metacognition in Kindergarten Education

Metacognition is the ability of individuals to know their cognitive functions, monitor them while they operate, to control and adjust them in order to optimize the adjustment to equivalent needs and requirements presented during the whole learning process. Researchers indicate a variety of components and subcomponents of metacognition, such as metamemory, monitoring, feeling of knowledge, and judgment of learning and conditional knowledge. The development of metacognition and specifically of monitoring, regulation, and adaptation, requires training of cognitive skills, such as attention, short-term and working memory [36].

Although relatively limited, metacognitive studies focusing on preschool children have shown that metacognitive processes play an important role in getting started of the learning course of young children and that their development already from preschool age lays the groundwork for the emergence of self-regulated learning [37]. Recent research data confirm this hypothesis that metacognitive knowledge, metacognitive skills and metacognitive experiences appear to some extent from preschool age. Children up to 4 years old have been found to exhibit metacognitive-type behaviour, such as intentional use of strategies, action planning, and self-control when engaged in simple and familiar projects. Research by Whitebread and his partners (2007) showed that even much young children (aged 3 to 5 years) in a familiar context of collaborative activities involving peer interaction reveal early forms of orientation, design and reflection, especially when the project is appropriate and matches their interests and levels of understanding. Also, in cases where the activities used were familiar to children, it was found that children were able to display strategic behaviour and make metacognitive assessments of the difficulty of the task or whether they know the answer, which goes hand in hand with their performance in similar projects [36, 38].

Furthermore, according to studies, from the end of preschool, children have a sense of mind, while in elementary school, they show that they have several metacognitive acquisitions, such as knowledge of memory and memory strategies. Older children can better recognize the importance of different metacognitive experiences, assess the degree of difficulty of a problem, and control their own cognitive behaviour [39]. Children typically talk about their thinking in the classroom, despite the fact that differences exist among children in the amount and content of this talk. The content of this talk is believed to be a reflection of metacognitive knowledge. Experiences within settings rich in problem-solving opportunities and feedback have been related to the acquisition of metacognitive knowledge. It seems reasonable to expect, therefore, that children's experiences with various activities may subsidize their metacognitive knowledge base and that different activity types may make available or more readily accessible different forms of information. Consequently, though there may not be differences in the extent of young children's metacognitive knowledge based on their individual interests, there may be differences in the content of their metacognitive knowledge and, as a result, the content of their metacognitive talk. Specifically, one might expect to see differences in the task versus person performance focus of children's metacognitive talk depending on their individual interest orientations during the early years prior to school [40].

On a general level, metacognitive abilities are important for children's cognitive functioning and problem solving, as is contextual metacognition, related to the problem the child is faced with. The period from 4 to 9 years of age is especially important for developing metacognitive abilities because during this period, children become aware of themselves as thinking individuals. Studies have shown that older preschoolers develop significant metacognitive potential, such as awareness and cognition about their own cognitive processes and self-control of cognitive performance. The improvement in metacognitive abilities helps children become successful in problem solving while the knowledge about cognition leads to proper detection of problems and selection of appropriate cognitive strategies. Children exhibit individual differences in choosing metacognitive strategies in problem solving while a higher developmental stadium and more experience lead children to use more adaptive strategies as these findings indicate a positive relation between metacognitive abilities and performance in problem-solving situations in preschoolers. In other words, problem-solving ability could enable metacognitive processes that will improve problem solving. By resolving interesting problems and acting in different tasks, preschool children develop highly ordered thinking and enhance their metacognitive potentials [41].

Schraw and Moshman (1995) observe that, although cognitive knowledge tends to improve with age, by the age of 4, children are able to theorize about their own thinking at a very simple level and appear to use simple theories to regulate their learning [36]. Similarly, Whitebread *et al.* (2009) found that children as young as 3-5 years old exhibited both verbal and nonverbal metacognitive behaviours during problem solving, including articulation of cognitive knowledge, cognitive regulation, and regulation of emotional and affective states [40]. McLeod (1997) points out that researchers have observed metacognition even in preschool-aged children, in the form of planning and monitoring progress toward goals and persistence at challenging tasks [36].

Kuhn (2000) characterizes the development of metacognition as the very gradual (and not always unidirectional) movement to acquire better cognitive strategies to replace inefficient ones. Several researchers have concluded that metacognitive abilities appear to improve with age [42]. Kuhn and Dean (2004) portray epistemological understanding as a benchmark in the development of metacognition. According to this developmental framework, preschool children are realists who equate believing with knowing. In other words, young children believe that everyone perceives the same thing, and all perceptions match external reality. By around age 4, however, children learn that some beliefs can be wrong. At this stage, called absolutism, children learn that two people's beliefs can differ, but only because one person is right and the other is wrong. By adolescence, most people recognize that even experts can disagree on certain topics. At this point, many descend into multiplism (or complete relativism), where everything is subjective, no beliefs can be judged, and all opinions are equally right. By adulthood, many people will have learned to tolerate some uncertainty while still maintaining that there can be better or worse opinions to the extent that they are supported with reason and evidence (evaluative epistemology).

Kuhn and Dean argue that there is very little that needs to be done to encourage children to progress through the first three stages; rather, it is progression to the fourth stage that requires some instructional effort [43].

Finally, Schneider and Lockl (2002) link the development of metacognition with the development of declarative metamemory, first evidenced by a child's understanding of mental verbs such as 'know', 'think', 'remember', and 'forget'. Preschoolers and kindergartners appear to have a limited understanding of memory, but they seem to understand the terms. From the age of 4 years on, memory verbs can be correctly applied to describe mental states [44]. Recently, in Greece, the curricula that schools follow, taking into account the theoretical and research data, is oriented to the development of the students' metacognitive skills through teaching. In particular, in the new kindergarten curriculum, the concept permeates the entire programme. The chapter on the role of the teacher and also other chapters suggest actions that the teacher can take in order to promote the learning of young children and consequently to develop their metacognitive skills.

More specifically, the Teacher's Guide to the Kindergarten Curriculum (2011) mentions that the teacher and children 'think' together to solve problems or interpret social and natural phenomena, the teacher guides and supports the children's learning with a dialogue between teacher and child, observes children and their activities to identify moments that can be used to help them learn something new (formulates mainly open-ended questions that motivate children to think at higher cognitive levels, uses a variety of teaching strategies, depending on the needs of the children and the content of the learning, organizes the environment and the learning process so that learning opportunities constantly arise, monitors and records the course of children's learning). Finally, the teacher encourages the development of cognitive strategies when it gives children the opportunity to contribute to the planning of an activity, to choose appropriate materials and techniques, to discuss what is more or less effective, to explain the difficulties encountered, to reflect on the consequences of their choices and act accordingly [45].

Figure 1: The Knowledge Pyramid (8 Layer Model). Stimuli (neural representations), Data (recruitment of discrete elements, communication), Information (interconnected data), Knowledge (Acceptance, interest in knowledge, organization of information, theories, axioms), Expertise & Discrimination (applied knowledge, creativity, experience, skills), Self-Actualization (Desire for creativity/innovation, mastering of skills), Universal Knowledge (Unification of laws and theories, conceptualization, prediction of behaviour, needs and problems, problem solving) Transcendence (Self-forgetfulness, loss of self-consciousness, transcendence of ego) [8].

IV Development of Metacognitive Skills in Kindergarten: The Eight-Layer Model

Children have to improve their skills of observing control, as well as of adapting their cognitive processes, through mental self-observation of their cognitive skills, in order to complete successfully the process of 'building' the pyramid of knowledge (Figure 1) and utilize the information to reach the top layer [8]. As we can perceive, for each layer of the pyramid of knowledge, we have to define the skills that will help children and individuals to organize their knowledge in order to jump directly to the next layer (Figure 2) [8].

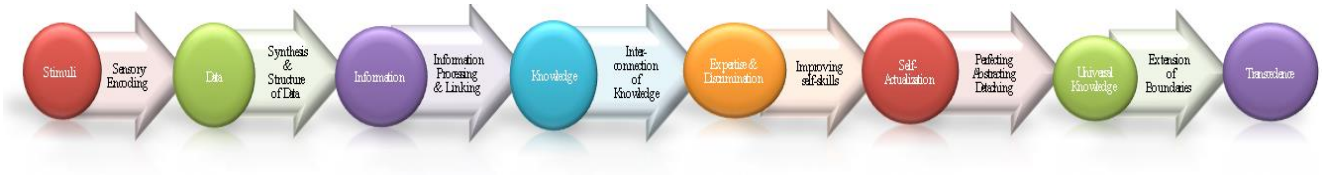

Figure 2: Cognitive and metacognitive processes required in order to move from a layer to another [8].

In other words, it is obvious that the metacognitive skills of each layer are not necessarily the same as any other layer. Preschool children observe stimuli and behaviour, and using their awareness of conflicting mental representations, give meaning to various concepts. In the pyramid of knowledge, in order to move from a layer to the higher one, some kind of energy should intervene, and so we can go from senses to data, from data to information, from information to knowledge, and so on. According to the constructivist perspective, gaining knowledge could be performed through self-organization. The development of meta-cognitive procedures, which we define as monitoring, regulation and adaptation, or in one word "consciousness" is the key for the individuals in order to move from one layer to the next one. A suggested way to assess young children's metacognitive knowledge is to analyse their verbal references when engaging in a cognitive task. More specifically, the answer to questions like "Why did you do that?" and "How you found it" by the child himself immediately after execution of a cognitive task is supported that requires the child to self-examine his thoughts, intentions and objectives in order to justify and explain his actions and the way of thinking he followed while performing it in a specific work [46].

According to the 'theory of mind' (ToM), young children can make thoughts about one's own or another's thought or belief [47]. Theory of mind is an area of developmental psychology, which by default involves a reference to mental states. It also enables one to understand that mental states can be the cause of - and thus be used to explain and predict others' behaviour. Between 3 and 5 years of age, children develop skills to consider their own and others' thoughts and feelings. Within this theoretical framework, Flavell (1999) concluded that children of that age understand basic things about thinking. More specifically, preschoolers show understanding that thinking is an activity that only people and perhaps some other animates engage in; that thinking is a private, internal procedure and that mental entities like thoughts and images are internal, in-the-head affairs, not to be confused with physical actions or other external objects and events; they also regard the mind and the brain as necessary for mental actions; they realize that like desires and other mental entities, thinking has content and makes reference, and that thoughts can take as their objects non-present and even non-real things. Thus, preschoolers understand some of the most basic and important facts about thinking: namely, that it is an internal human activity that refers to or represents real or imaginary things. Finally, they have some ability to infer the presence of thinking in another person provided that the cues are very strong and clear, and they also can differentiate thinking from other activities in such situations [48].

In this chapter, we analyse the development of the metacognitive skills in preschoolers from the age 3 to 6, recording the different levels of acquisition, taking into account the 8-layer pyramid of knowledge (Figure 1). As follows, we present the 8-layer model (pyramid) of metacognitive skills with respect to preschool education and the cognitive development of the individual (Figure 3). For each layer of the pyramid, we define the cognitive skills that each child should train in order to conquer the skills of the corresponding layer and move to the next one, as well as the additional metacognitive skills required. As it is easily understood, as we move towards the top of the pyramid, we find increasingly smaller portion of the preschoolers with the corresponding skills. The layers correspond to a set of abilities and skills ranked on account of their difficulty to acquire and their significance on multi-level cognitive experiences. The reason for the hierarchy presented is illustrated on the aforementioned theories that drew attention to one's handling of competencies according to the environmental surroundings. Moreover, cognitive flexibility accompanied by an adaptable character and fruitful external condition may lead to one's personal growth. The role of language and verbal ability is thought significant and important for each level [49].

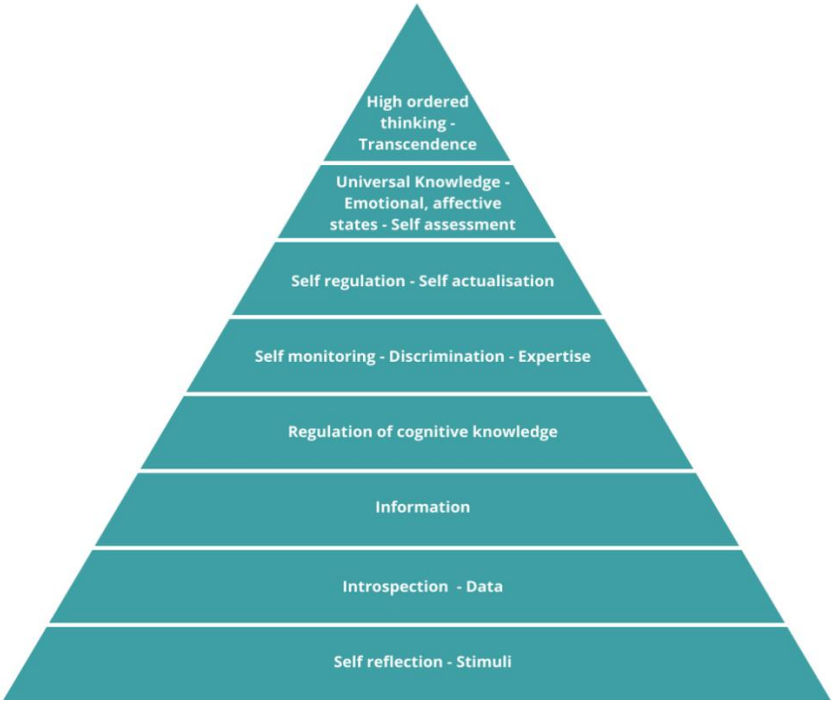

Figure 3: The 8-layer model of metacognitive skills in preschoolers.

i Self-Reflection – Stimuli

During this phase, the evaluation of the learning outcome takes place, as well as the contribution of the self to it. The student reflects on the learning task with questions such as "What helped me?", "What prevented me from the context?". The teacher encourages the students to activate thoughts and self-questions that are mentioned through the solution process. For example, to check if they achieved their initial goal, to evaluate their performance, and to reflect on what new they learned. More specifically, the identification, the selection, the recruitment, the processing, the storage, the organization, and the transformation of the subject are involved in the cognitive processes [50]. As a result, preschool children observe stimuli and behaviour and using their awareness of conflicting mental representations give meaning to various concepts while invading stimuli enter encoded, as neural representations, into the cognitive processing system and thus can be used for subsequent processing. During the process of reflection, the child considers the possibilities and limitations of the self when completing a task and thinks about how he can better cope with such an effort [8].

ii Introspect – Data

At this stage preschoolers start to have thoughts and feelings and observe their mental states. In addition to the understanding of the stimuli they take, at the second level, children start to collect data – a collection of facts, generated by sensory stimuli that they perceive through their senses. At this stage, preschoolers give value to a given set of data and store it in their memory in order to use them for possible later exploitation. This understanding enables children to predict and explain actions by ascribing mental states, such as beliefs, desires, and intentions to themselves and to other people [51].

iii Information

Information could be defined as organized and structured data. However, in this step, children start to understand the existence of the basic cognitive abilities (attention, memory, perception, association, pattern recognition, perceptual speed, action, mental imagery, problem solving, language) and how they are related to each other [50]. However, we have stated that there is a clear distinction between the terms “information” and “knowledge”, as the amount of information we perceive will not necessarily lead to the process of knowing. This explains a certain pathogenicity of the educational system, as in many cases, students acquire information but not knowledge [8].

iv Regulation of Cognitive Knowledge

At this level, preschoolers start to transform information into knowledge through personal experience, beliefs, and values, and thus knowledge formed though the same information differs from an individual to another. This knowledge ensures the awareness of personal enduring characteristics and temporary conditions influencing one’s performance, the knowledge of task requirements, purposes and scope to attack the problem/task efficiently, and (the awareness of relevant strategies along with the recognition to apply them. In this phase children start to understand about the operational knowledge about the functionality of cognitive abilities, their cognitive freedom degrees, and cognitive constraints [52].

v Self-Monitoring – Discrimination – Expertise

Expertise could be characterized as a well-organized and interconnected domain of specific knowledge, which allows individuals (experts) to overlap working memory limitations. At this stage, preschoolers have a wide range of cognitive capabilities, including the ability to make reliable and consistent discriminations between different stimuli, to estimate numerical values, to predict future outcomes, etc. This is a metacognitive skill that allows the child to monitor his action in solving cognitive tasks. It is considered a basic metacognitive skill, which is directly related to the self-image of the student's abilities [53]. It is considered as internal attention – the ability to watch and to perceive in real time the cognitive states and operations. In the field of Pedagogy, a team (2016) reports on the promotion of self-observation that through this, the child acquires skills that enable him to observe, identify and see critical elements of his learning process or work. It is a form of internal feedback, where information on what was done successfully and what was not, in relation to a given goal come from oneself. In this direction, the role of the teacher is supportive when he discusses with the child about the procedures followed until the completion of a project and consults with him the data that has the result to which he was led [54].

vi Self-Regulation – Self Actualization

According to Rogers (1959), from the birth of an individual and through his life, the only driving force is the tendency for actualization while aiming at the positive recognition from their social environment. The process of becoming an expert requires the development of creativity, motivation and self-actualization, and in most cases involves failure. According to Maslow (1965), the far objective of self-actualization is intrinsic learning as for example, to help people achieve what they are capable of. Individuals can reach self-actualization only if they have covered all of their other needs and are now possessed by the desire for creativity. The achievement of self-actualization increases the possibility of self-transcendence, as the individual can merge himself/herself as a part of a larger whole. Furthermore, metacognitive regulation includes the components of evaluation, and monitoring while the concepts of critical thinking and self-regulation seem to be fundamental components of children’s metacognitive skills. Wiggins (1998) approaches the concept of metacognition, arguing that the child, reflecting on his practices, has the ability to self-evaluate and develop. Self-regulation gives the child the ability to change, to regulate, and to fine tune via decisions [8, 55].

vii Self-Assessment – Emotional and Motivational Regulation – Universal Knowledge

Self-assessment is defined as a process by which students monitor and evaluate the quality of their thinking and learning behaviour and identify strategies that improve their understanding and skills, that is, self-assessment occurs when students judge their work to improve their performance and identify discrepancies between current and desired performance. It includes children’s ongoing monitoring and control of emotions during learning tasks, and the reasons for their success or failure [56]. It is important to experience it also as a part of the kindergarten routine and to connect with learning. Children 's understanding of the purpose and success criteria of an activity in which they are involved is necessary to be able to gradually describe their

achievements and build self-assessment skills. This ability to change the operational status of cognitive abilities help children to be more productive, successful, and happy. With the term universal knowledge, we define the integrated knowledge that unites all the existing theories of the universe in one global theory. At this level, children as a result might assimilate the unification of laws and theories governing the universe, require expertise in various knowledge domains and gain the ability to see what others do or don't [8, 50].

viii Higher-Order Thinking – Transcendence

At this level, critical thinking, motivation, and planning give children the opportunity to have better academic and personal performance. Children with high ordered thinking have more positive social relationships at school, which in turn increases their level of engagement and academic motivation. Furthermore, at this stage, children start to adopt beliefs and attitudes that underlie the development and the expression of motivation and high-quality thinking. Transcendence is strongly correlated with self-esteem and emotional well-being. Children who have reached self-transcendence can encourage others to expand self-boundaries and self-actualize [49]. Finally, at this level, children start to filter and make selection among cognitive and emotional situations, make choices that are more helpful and positive, and start to understand external and internal states in their full range and depth, resulting in their better understanding of what they really are [50].

Conclusion

Early research tended to conclude that metacognition is a late-developing skill. The metacognitive capacity of preschool children is limited by several factors, including the development of executive functioning and verbal ability. The maturation of the portions of the brain responsible for executive functioning does not occur until 3-6 years of age, which parallels the emergence of cognitive skills such as inhibitory control. Theory of mind, which may in turn be dependent on the development of verbal reasoning skills as well as many metacognitive skills. More recent research suggests that young children are capable of rudimentary forms of metacognitive thought, particularly after the age of 3. Preschool-aged children will demonstrate metacognitive behaviours, such as articulation of cognitive knowledge, regulation of thought, and regulation of emotional and affective states.

A number of researchers have proposed alternative models of metacognitive development over time. Although individual developmental models may vary, in general, they all postulate massive improvements in metacognitive ability during the first 6 years of life, with the most dramatic changes occurring between the ages of 3 and 4. Cognitive knowledge tends to emerge first, with regulation of cognition not appearing until much later. Metacognition improves with both age and appropriate instruction, with substantial empirical evidence supporting the notion that students can be taught to reflect on their own thinking. Researchers recommend a number of specific instructional strategies, including providing explicit instruction in both cognitive knowledge and cognitive regulation, using collaborative or cooperative learning methods, using tasks and activities that make student conceptions and beliefs visible, promoting awareness of metacognition through teacher modeling, and attending to the affective and motivational aspects of metacognition. This paper tried to show that metacognitive skills in preschoolers is a sophisticated process that requires the proper development and collaboration of cognitive functions. This new metacognitive based taxonomy could be applied to the field of preschool education in order to support teachers to teach metacognitive skills as well as to assess children to have better learning outcomes.

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