

**Manifestations of Metacognition and Self-Regulation among  
Preschoolers during Scientific Experiences and the Role of  
the Learning Environment**

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## **Abstract**

In the last three decades, the research literature has grown richer with empirical findings testifying to young children's high cognitive abilities. Findings indicate that children of preschool age, and even younger than that, have the cognitive skills needed for abstract and deductive thinking, the ability to implement scientific research skills and to understand scientific concept, in addition to metacognitive thinking and self-regulation processes. These findings enhance the importance of implementing science education and fostering young children's natural tendency to explore and to learn about the world around them. The main purpose of this study is to identify and assess the extent of implementation of exploration capabilities and instances of metacognitive strategic awareness, and self-regulation capabilities among 5-6-year-olds during structured or open-ended scientific experimentation task, and to examine the relationship between these capabilities. To the best of our knowledge, after a thorough review of the literature, this relationship has not yet been investigated in the context of scientific exploration in which the child operates autonomously.

We assessed the extent of implementation of these abilities in a number of situations: spontaneous abilities without intervention, abilities after a 5-months intervention program, an examination of the effect of the children's background data (gender, receptive vocabulary, innate fluid non-verbal intelligence, parental education and occupation) on these abilities. The research population comprised of 215 children aged 5-6 years, 128 parents and 10 preschool teachers of 10 state preschools. The baseline tests (Raven, PPVT) showed all the children as typically developed. The study developed two scientific exploration tasks – open-ended and structured. Every child was recorded on video while engaged in the exploration tasks – before and after the intervention. The children's abilities were analyzed by of the videos. For the microanalysis, we developed a scoring rubric that examines scientific thinking, inquiry, metacognitive strategic awareness and self-regulation capabilities. By means of this scoring rubric, we analyzed the children's verbal and behavioral responses, and coded in detail about 180 video hours. We conducted validation and inter-rater reliability processes with three early childhood educators and three early science education researchers. In addition, we collected data from holistic observations in the preschools and conducted semi-structured interviews with the teachers.

This study is presented in this dissertation in the form of three papers. The first paper **Identifying Nascent Inquiry, Metacognitive Strategic Awareness and Self-Regulation Capabilities among Preschoolers During Scientific Exploration**, investigates nascent scientific thinking and ability to implement inquiry processes, instances of metacognitive strategic awareness and self-regulation capabilities among young children (N=215) in the context of open-ended scientific exploration. Part of the research population was also examined in the course of a structured exploration task. The second paper, **Multiple encounters with scientific exploration: A way of fostering inquiry, metacognitive strategic awareness and self-regulation capabilities among preschoolers**, presents an intervention research (pre-post) that examines how enriching the science center in the preschool for 5 months, with varied scientific equipment and materials calling for exploratory behaviors, affects the implementation of inquiry, metacognitive strategic awareness and self-regulation capabilities among preschoolers, in the context of open-ended scientific exploration task. The intervention program took place in half of the research preschools and involved 108 preschoolers. The comparison group included 92 preschoolers. The learning environment was enriched with equipment irrelevant to science. The study presented in the third paper - **What Factors Influence Preschoolers' Scientific Inquiry Capabilities, Metacognitive Strategic Awareness and Self-Regulation Capabilities**, examines how the preschoolers background data, such as gender, receptive vocabulary, fluid general intelligence, and parental occupation and education affect preschoolers' inquiry capabilities, metacognitive strategic awareness and self-regulation capabilities in the course of carrying out an open-ended scientific exploration task.

The findings presented in the three papers indicate that young children manifest the ability to implement inquiry capabilities (posing question, hypothesizing, planning, using tools, drawing conclusions) and instances of metacognitive strategic awareness as well as capabilities of self-regulation (planning, monitoring, control and assessment), in the context of scientific exploration tasks. Certain capabilities were manifested more in the context of the open-ended task and other capabilities in the context of the structured scientific assignment. Findings indicated variance between participants' capabilities. Significant relationships were found between abilities of implementing inquiry capabilities and abilities of metacognitive strategic awareness and self-

regulation capabilities. Another significant finding is the extent of improvement in these capabilities after the 5-months intervention program that included exposure to tools, materials and scientific phenomena calling for exploratory behaviors. The participants of the intervention group improved their inquiry capabilities: hypothesizing, use of tools, asking question and drawing conclusions. In addition, the lack of self-regulation index decreased. Findings indicate that gender has no effect on the abilities measured, while the kind of task does. Some capabilities were performed better in the context of the open-ended exploration task, and some in the context of the structured task. Regarding the effect of parents' occupation and education, findings indicate that the father's occupation related to science affects the measures: use of tools, persistence and autonomy. Participation in the intervention group predicted mostly the metacognitive strategic awareness and self-regulation capabilities. Another interesting finding is that belonging to a group (intervention or comparison) has a significant inverse relationship to lack of self-regulation. The more the participant experiences exploration in the science inquiry center in the preschool, the more s/he manages to regulate her/his behavior, s/he demonstrates less lack of self-regulation. On the theoretic level, the study findings are important as they contribute to the understanding of young (aged 5-6 years) preschoolers' relatively high cognitive capabilities. To the best of our knowledge, this kind of research, analyzing children's capabilities concerning both inquiry skills and aspects of metacognition and self-regulation in the context of authentic scientific exploration tasks has not been reported yet in the literature. As to the methodology, the intervention program and the tools developed in this study, that is, age-appropriate science exploration tasks and a scoring rubric for analyzing children's verbal and behavioral responses, might aid educators and researchers wishing to examine these capabilities in young children. From the practical point of view, this study facilitates the forming of recommendations for learning-environment organization and activities promoting the development of inquiry capabilities, metacognition strategic awareness and self-regulation capabilities in young children.



