Research Summary:
Cognition: Science (COG: SCI) Domain in the DRDP-K (2015) and KIDS (2015) Kindergarten Assessment Instruments

The **Cognition: Science (COG: SCI)** domain focuses on observation, exploration, investigation of objects, and learning of key concepts. The COG: SCI domain includes the following knowledge or skill areas: cause and effect, inquiry through observation and investigation, documentation and communication of inquiry, and knowledge of the natural world.

COG: SCI 1: Cause and Effect

The cause and effect measure addresses the ability to relate events causally and identify cause-and-effect relations. Much of the understanding of core concepts in science rests on the ability to identify cause-and-effect relations. Everyday experiences—for example, crying and then being picked up—provide opportunities for infants to learn about cause and effect. "Even very young infants possess expectations about physical events" (Baillargeon, 2004, p. 89). This knowledge helps infants better understand the properties of objects, the patterns of human behavior, and the relationship between events and the consequences. "When variations in the child's action result in corresponding variations in an object's reaction, children have an opportunity to construct knowledge of corresponding events and to become aware of **cause-and-effect** relationships (Kamii & DeVries, 1993; DeVries, Zan, Hildebrandt, Edmiaston, & Sales, 2002)" (California Department of Education, 2010, p. 86). Through developing an understanding of cause and effect, young children are able to build their abilities to solve problems, to make predictions, and to understand the impact of their behavior on others." At a very young age children understand the causal relations involved in everyday physics. For example, young children can reason about the kind of mechanism that can or cannot produce a certain outcome (such as pulling, pushing, or rolling). First, they "typically assume that physical events have a cause and intuitively search for a cause. They are also sensitive to the temporal ordering of cause-and-effect and believe that causes must precede their effects. Finally, young children can reason about the kind of mechanism that can or cannot produce a certain outcome (such as pulling, pushing, or rolling). For example, when observing a cause-and-effect event in which a ball rolled against a jack-in-the-box, children could reason about the cause and effect. They attributed the effect to the ball hitting the jack-in-the-box, presumably because rolling and hitting can produce movement in another object through impact. When asked to explain how an event occurred, some children generated mechanistic, physically oriented explanations (Bullock, Gelman, & Baillargeon, 1982)" (California Department of Education, 2010, p. 88).

From the later preschool years and into early elementary years children progress in their ability to reason about the relationship between cause and effect. This includes the understanding that variations in actions cause corresponding variations in results, the ability to reason more abstractly about cause and effect (i.e., that effects may arise from causes that are not easily perceived), and the ability to investigate and gather evidence about causes of observable events.

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COG: SCI 2: Inquiry through Observation and Investigation

The inquiry through observation and investigation measure focuses on children's ability to observe and investigate objects and events in their everyday environment. "During the preschool years, children are developmentally ready to engage in scientific skills, such as observation, classification, comparing, and predicting (Gelman & Brenneman, 2004; French, 2004; Gelman, Brenneman, Macdonald, & Roman, 2010)" (California Department of Education, 2010, p. 84). Scientific investigations in the early years are largely based on systematic observations. Children engage in detailed observations of objects and events in their environment.

"Through observations and by acting on objects, children learn about the physical characteristics of objects (size, shape, material, or weight), and how objects interact, move, and change. This information feeds children's growth in understanding concepts and acquiring knowledge in core domains such as biology and physics" (California Department of Education, 2010, p. 84).

"As children develop their inquiry skills, they can use prior knowledge and observable information to predict future events (Jones, Lake, & Lin, 2008)" (California Department of Education, 2010, p. 84). Research indicates that preschool children are capable of using their knowledge to make predictions of different natural phenomena. In domains in which young children have conceptual knowledge, their predictions tend to be relatively reasonable and accurate (Bullock, Gelman, & Baillargeon, 1982; Inagaki & Hatano, 2002; Zur & Gelman, 2004). "Young children can also use observable evidence to make inferences or draw conclusions. Research indicates that they can make accurate inferences on the basis of relevant evidence. For example, very young children can infer causal relations and accurately conclude, based on patterns of evidence, what causes a machine to light up and play music (Gopnik, Sobel, Schulz, & Glymour, 2001)" (California Department of Education, 2010, p. 85).

This measure involves children's ability to engage in detailed observations and complex investigations, ask questions based on observations, plan and conduct an investigation to answer a specific question of interest (with adult guidance), use information from resources to expand on observations and investigations, and collect data that can serve as the basis for evidence to answer specific questions on scientific topics (National Research Council, 2013).

COG: SCI 3: Documentation and Communication of Inquiry

The documentation and communication of inquiry measure pertains to processes and skills employed to document and record observations and to communicate ideas and explanations to others. "Preschool children learn to use language to describe their observations and communicate their thoughts" (California Department of Education, 2010, p. 85). "The use of language to describe observations and other steps in the exploration process is an integral part of children's learning and formation of scientific concepts (Gelman & Brenneman, 2004; Eshach, 2006). Language extends and enriches scientific experiences and facilitates conceptual growth. For example, as children explore concepts such as growth, nutrition, or weather, they gradually learn the terms for the concepts they explore. The use of these terms, in turn, enriches their

learning experiences. Children may also begin to use relevant scientific terms—for example, 'I *observe,'* 'My *prediction* is,' and 'Let me *check'*—as they practice inquiry skills across a variety of settings (Gelman & Brenneman, 2004). English learners, for whom the development of new vocabulary and language skills is most effective in authentic learning experiences, especially benefit. In the context of scientific explorations, children also learn to engage in complex discussions involving observation, prediction, and explanation (Peterson & French, 2008). Such discussions develop children's understanding of the scientific phenomena they explore (Jones, Lake, & Lin, 2008)" (California Department of Education, 2010, p. 85–86).

From the later preschool years and into the early elementary years children progress in their ability to record detailed information in different ways, to start analyzing and interpreting data (e.g., identify patterns in recorded data), and to construct and communicate explanations based on recorded evidence.

COG: SCI 4: Knowledge of the Natural World

The knowledge of the natural world measure pertains to children's understanding of the essential properties of living things and natural events. At a young age, young children understand the difference between animate and inanimate objects, and some aspects of growth in animals and plants. For example, they recognize that plants, but not objects, are similar to animals in terms of growing, needing food or water, and becoming older and dying. "It is believed that children's ability to distinguish between animate and inanimate objects is a foundation, or a precursor, to the ability to make the more general distinction between living and nonliving things (Inagaki & Hatano, 2002)" (California Department of Education, 2010, p. 88).

"Preschool children understand that animals and plants grow and increase in size over time as they mature. (Rosengren, Gelman, Kalish, & McCormick, 1991; Hickling & Gelman, 1995). Five-year-old children recognize that plants, but not objects, are similar to animals in terms of growing, needing food and/or water, and becoming older and dying (Inagaki & Hatano, 1996)" (California Department of Education, 2010, p. 90). "Preschool children understand some aspects of growth in animals and plants. By three years of age, children realize that growth in animals involves an increase in size over time. They realize that growth in animals is affected by food intake, not by an intention or desire to grow (Inagaki & Hatano, 2002). Older children, approximately five years of age, also expect some animals to change in appearance with age. They understand that animals undergo metamorphosis—for example, caterpillars change into butterflies, and tadpoles change into frogs (Rosengren, Gelman, Kalish, & McCormick, 1991). However, they realize that in natural transformations, such as growth or metamorphosis, the identity of animals remains constant despite changes in appearance with age (Gelman, 2003)" (California Department of Education, 2010, p. 91).

"Between the ages of four and five, children develop increasing knowledge about plants, including an understanding of some of the characteristics of plant growth and the nature of seeds (Hickling & Gelman, 1995). Older four-year-olds realize that seeds originate from a natural source, specifically from same-species plants, not from other types of plants, and that people cannot make seeds. Older four-year-olds also expect external, natural mechanisms (sunshine

and rain), rather than human activity or the intention and desire of the plant, to initiate the growth process" (California Department of Education, 2010, p. 91).

"Young children can observe and become aware of the earth's resources and phenomena, but they are not ready to grasp scientific concepts and explanations of the earth's phenomena such as the cause of the day/night cycle rotation or of seasonal changes (Kampeza, 2006)" (California Department of Education, 2010, p. 92).

From the later preschool years and into the early elementary years children progress in their understanding and knowledge of specific characteristics of living things and phenomena in the natural world. This includes greater knowledge of variation and diversity of living things (i.e., different categories), basic needs of living things, habitats, and patterns of changes in living things and in the natural environment.

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