Chapter 18
On Cognitive Foundations of Creativity and the Cognitive Process of Creation

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ABSTRACT
Creativity is a gifted ability of human beings in thinking, inference, problem solving, and product development. A creation is a new and unusual relation between two or more objects that generates a novel and meaningful concept, solution, method, explanation, or product. This article formally investigates into the cognitive process of creation and creativity as one of the most fantastic life functions. The cognitive foundations of creativity are explored in order to explain the space of creativity, the approaches to creativity, the relationship between creation and problem solving, and the common attributes of inventors. A set of mathematical models of creation and creativity is established on the basis of the tree structures and properties of human knowledge known as concept trees. The measurement of creativity is quantitatively analyzed, followed by the formal elaboration of the cognitive process of creation as a part of the Layered Reference Model of the Brain (LRMB).

INTRODUCTION
Creativity is a gifted ability of human beings in thinking, inference, problem solving, and product development (Beveridge, 1975; Csikszentmihalyi, 1996; Holland, 1986; Matlin, 1998; Smith, 1995; Sternberg & Lubart, 1995; Wang et al., 2006; Wilson & Keil, 1999). Human creativity may be classified into three categories known as the abstract, concrete, and art creativities. A scientific (abstract) creation is usually characterized by a free and unlimited creative environment where the
goals and paths for such a creation is totally free and unlimited; while an engineering (concrete) creation is characterized by a limited creative environment where a creative problem solving is constructed by a certain set of goals, paths, and available conditions. The third form of creation is the art (empirical) creation that generates a novel artifact that attracts human sensorial attention and perceptual satisfactory.

Creativity has been perceived diversely and controversially in psychology, intelligence science, and cognitive science (Csikszentmihalyi, 1996; Guilford, 1967; Leahey, 1997; Mednich & Mednich, 1967; Matlin, 1998; Sternberg & Lubart, 1995; Wallas, 1926; Wang et al., 2009a, 2009b). Creativity may be treated as a form of art that generates unexpected results by unexpected paths and means. It may also be modeled as a scientific phenomenon that generates unexpected results by purposeful pursuits. In 1998, Matlin perceived that creativity is a special case of problem solving (Matlin, 1998). From this perspective, he defined creativity as a process to find a solution that is both novel and useful. However, problem solving often deals with issues for a certain goal with unknown paths. Therefore, creation is much more divergent that deals with issues of both unknown goals and unknown paths for a problem under study.

The nature of creations is a new and unusual relation between two or more objects that generates a novel and meaningful concept, solution, method, explanation, or product. This article investigates into the cognitive process of creation and creativity as a higher-layer life function. Cognitive foundations of creativity are explored on such as the space of creativity, the approaches to creativity, the relationships of creation and problem solving, and the attributes of creative researchers. A set of mathematical models of creation and creativity is developed by studying the tree structures and properties of human knowledge known as concept trees. On the basis of the concept tree, the measurement of creativity is quantitatively analyzed. The cognitive process of creation is rigorously elaborated with Real-Time Process Algebra (RTPA) (Wang, 2002a, 2007a, 2008a, 2008e), which provides a formal explanation of human creativity.

**COGNITIVE FOUNDATIONS OF CREATIVITY**

Human creativity as a gifted ability is an intelligent driving force that brings something into existence.

**Definition 1.** Creativity is the intellectual ability to make creations, inventions, and discoveries that brings novel relations and entities or unexpected solutions into existence.

**Definition 2.** A creation is a higher cognitive process of the brain at the higher cognitive layer that discovers a new relation between objects, attributes, concepts, phenomena, and events, which is original, proven true, and useful.

Wallas identified five stages in a creative process (Wallas, 1926) as follows: (1) preparation, (2) incubation, (3) insight, (4) evaluation, and (5) elaboration. Csikszentmihalyi pointed out that creativity can best be understood as a confluence of three factors: a domain that consists of a set of rules and practices; an individual who makes a novel variation in the contents of the domain; and a field that consists of experts who act as gatekeepers to the domain, and decide which novel variation is worth adding to it (Csikszentmihalyi, 1996).

Various creativities and creation processes may be identified such as free/constrained creativity, analytic/synthetic creativity, inference-based creativity, problem-solving-based creativity, and scientific/technological/art creativity. The entire set of creativities can be classified into three categories according to their creation spaces, approaches, and problem domains as summarized in Table 1.