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Creative Thinking Processes: The Past and the Future

ABSTRACT

For more than one hundred years, students of creativity, including seminal efforts published in the *Journal of Creative Behavior*, have sought to identify the key processes people must execute to produce creative problem solutions. In recent years, we have seen a consensual model of key creative thinking processes being accepted by the field. In the present effort, we review the evidence bearing on the eight core processes proposed in this consensual model. Subsequently, directions for future research on creative thinking processes are discussed.

Keywords: creativity, creative thinking, processes, cognition, knowledge.

The many, and varied, influences on creative performance broaches a fundamental question (Mumford, Hunter, & Byrne, 2009). What is the basis for peoples' production of creative problem solutions? In fact, over the years, the *Journal of Creative Behavior* has published a number of articles which hoped to provide an answer to this question (e.g., Isaksen & Treffinger, 2004; Parnes & Biondi, 1975). As Parnes and Noller (1972) pointed out, the answers we provide to this question influence not only theory (Weisberg & Hass, 2007) but also how we seek to develop (Scott, Leritz, & Mumford, 2004), assess (Vessey & Mumford, 2012), and manage (Mumford, Martin, Elliott, & McIntosh, in press) creative people.

One approach that has been used to answer this question is identification of the cognitive processes people must execute to produce creative problem solutions. And, over the years, a number of models describing peoples' creative thinking processes have been proposed (e.g. Dewey, 1910; Sternberg, 1986). In recent years, however, the model proposed by Mumford, Mobley, Reiter-Palmon, Uhlman, and Doares (1991) has become the standard by which we understand the key processing operations needed for creative thought. In the present effort, we will examine past work bearing on this model and its implications for future work on creative problem solving.

THE PAST

Mumford et al.' (1991) model was based on three assumptions: (a) creative problem solving requires the production of high quality, original, and elegant solutions to complex, novel, ill-defined problems, (b) problem solving requires knowledge or expertise, and (c) although different performance domains impose different knowledge requirements, and stress, weight, processes differently, similar processes would underlie creative thought in most domains of endeavor. These observations, coupled with a review of prior studies, led Mumford et al. (1991) to propose the eight process model presented in Figure 1.

Because creative problems are novel, complex, and ill-defined, it is held that creative problem solving begins with problem definition. Problem definition provides the basis for information gathering which, in

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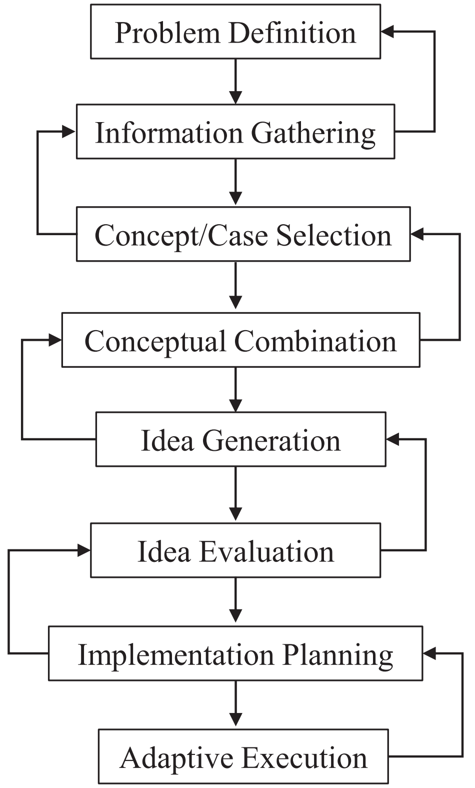

FIGURE 1. Creative process model.

turn, allows people to select the concepts, or cases, that might be used to understand the problem. Peoples' combination, or reorganization, of these concepts, or cases, allows people to generate new ideas. And, these ideas, following idea evaluation, are used to formulate implementation plans. Execution of these plans in an adaptive, opportunistic, fashion gives rise to creative problem solutions. Both divergent and convergent operations are required in executing each process with people cycling back if the outputs of process execution are found inadequate.

EVIDENCE FOR MODEL

Over the years, I and my colleagues, have sought to provide evidence for the validity of this model. One set of studies, studies by Baughman and Mumford (1995), Mobley, Doares, and Mumford (1992), Scott, Lonergan, and Mumford (2005) has shown new ideas, in fact, arise from combination and reorganization of extant knowledge—often through a search and mapping of shared and non-shared features. Other studies have provided evidence for the impact of the other processes proposed in this model—processes such as problem definition (Reiter-Palmon, Mumford, & Threlfall, 1998), idea evaluation (Lonergan, Scott, & Mumford, 2004), and implementation planning (Osburn & Mumford, 2006). Still, other work by Vincent, Decker, and Mumford (2002) has shown effective execution of these processes is based on expertise, intelligence, and divergent thinking ability.

Another set of studies have examined the predictive power of these processes in accounting for performance on creative problem-solving tasks. Mumford, Supinski, Baughman, Costanza, and Threlfall (1997) asked undergraduates to provide solutions to two problems, both complex, novel, ill-defined problems, where problem solutions were appraised by judges for quality and originality. The effectiveness with which participants executed various processes, problem definition, information gathering, concept/case selection, and conceptual combination, was assessed through an independent set of tasks intended to appraise the effectiveness of process execution. It was found that effective execution of each process contributed to creative problem solving on multiple tasks. Effective process execution added to the prediction obtained from basic abilities such as intelligence and divergent thinking. And, the overall, cross-process, prediction of solution quality and originality was impressive with multiple correlations in the .50's emerging—given quality and originality reliabilities in the high .70's.

In still another set of studies, Friedrich and Mumford (2009) sought to determine whether these processes were causally linked as indicated by Mumford et al.'s (1991) model. In this study, undergraduates were asked to provide solutions, solutions appraised by judges for quality, originality, and elegance, to a creative marketing problem. At different points in problem solving, as people executed different processes, conflicting information was induced to disrupt process execution, and the effectiveness of process execution was assessed. It was found, in keeping with Mumford et al.'s (1991) model, that errors induced in earlier processes (e.g., problem definition) disrupted subsequent (e.g., information gathering) process execution.

These studies of process execution and prediction are not the only evidence for Mumford et al.'s (1991) model of creative thinking processes. For example, effective execution of these processes has been shown to be strongly ($R \approx .40$) related to creative performance on jobs where creative thought is at a premium (Vincent et al., 2002). The operations contributing to effective execution of each process, for example the search for key facts and anomalies, make sense given what is known about creative achievement (Mumford et al., in press). And, the nature of the knowledge, and knowledge structures (e.g., mental models) employed, has been found to influence the effectiveness of process execution (Hunter, Bedell-Avers, Hunsicker, Mumford, & Ligon, 2008; Mumford et al., 2012). Thus, Mumford et al.'s (1991) model seems to provide a plausible description of the key processes underlying creative thought.

THE FUTURE

The evidence accrued for this model of creative thinking processes not only enhances our understanding of creative thought, it points to a number of new directions for future research on creativity. In the present effort, we would like to underscore what we believe to be three key issues: (a) the methods used in studies of creativity, (b) the key substantive issues arising in creativity research, and (c) applications of our research for the assessment and development of creative potential.

METHOD

Studies of creativity often focus on jobs, aggregates of tasks, commonly held to call for creativity (e.g., scientists, artists), or alternatively, overall impressions by others of a person's creativity. In Mumford et al.'s (1991) model, however, it is held that these processes are executed only on certain kinds of tasks—tasks that present people with complex, novel, ill-defined, or poorly, structured problems. Thus there is little value in studying creativity on jobs where people are not presented with complex, novel, ill-defined problems. This observation is noteworthy because it implies we must begin to specify when, where, and how people are asked to solve creative problems in their work before we start to draw inferences about creativity.

Notably, different types of work stress effective execution of certain processes in producing creative problem solutions. Thus, Mumford, Antes, Caughron, Connelly, and Beeler (2010) found that different fields stressed the effective execution of certain processes in creative problem solving. For example, the social sciences stressed conceptual combination and idea generation, where the biological sciences stressed information gathering and idea evaluation. Given these findings, it would seem we should not only justify the need for creative problem solving in our studies, we should also indicate which specific processes are critical to producing creative problem solutions in a particular domain. As Fleishman, Quaintance, and Broedling (1984) have pointed out, greater specificity in assessing the key components of performance in different domains typically results in far more rapid advances in our understanding of a phenomena. In fact, Mumford et al.'s (1991) process model may provide students of creativity with a way of isolating these key elements of creative thought.

SUBSTANCE

A key proposition of Mumford et al.'s (1991) model is that effective execution of all these processes in creative problem solving depends on the type, or nature, of the knowledge with which a person is working. Over the years, the use of conceptual, schematic, case-based, or experiential, and associational knowledge in creative thought has been debated (Hunter et al., 2008). More centrally, however, Scott et al. (2005) have shown that different types of operations are used in executing a given process when people are working with different types of knowledge. Thus, when working with concepts in conceptual combination, feature search and mapping operations are critical. But, when working with cases in conceptual combination, analysis of strengths and weaknesses, and forecasting to context, are critical. Thus, future research on the operations giving rise to effective process execution should examine the operations involved in process execution with respect to specific types of knowledge.

Regardless of the knowledge employed, execution of any creative thinking process is, unto itself, a complex activity calling for execution of multiple different operations. Some of these operations are divergent, for example, the emergence of new features through generation and elaboration of new exemplars in conceptual combination, while other operations, for example, feature search and mapping in conceptual combination, are convergent. This observation is noteworthy because it suggests we must drop the old dichotomy between divergent and convergent thinking. Instead, we should begin to ask how various divergent and convergent operations work together to permit effective execution of a particular creative thinking process (Cropley, 2006).

Traditionally, students of creativity have focused on the value of an idea—any idea. The model proposed by Mumford et al. (1991), however, suggests it is not ideas per se that are critical to creative problem solving, but rather the outputs of process execution. This point is noteworthy because it suggests that some "ideas" are of no value because these "ideas" may induce errors in effective execution of certain processes. We need to start thinking about when, and how, ideas influence, for good or ill, the effective execution of certain creative thinking processes. More broadly, we have, for some time, ignored the importance of errors in creative problem solving. Mumford et al.'s (1991) model, however, suggests that errors may arise in execution of any creative thinking process. And, understanding when, and how, errors in execution of any given creative process influence subsequent creative problem solving may prove critical to understanding creative thought (Licuanan, Dailey, & Mumford, 2007).

Of course, different errors will be of significance in understanding execution of different creative thinking processes. However, these errors and/or effective execution of different processes, may be influenced by different contingencies—attributes of the situation or attributes of the person. For example, attention and motivation may be more important in problem definition than in concept/case selection. This observation is noteworthy because it suggests that inferences should be drawn not to creative thought overall, but rather to specific processes involved in creative thought.

APPLICATIONS

Of course, the substantive questions raised above point to a host of new studies which need to be conducted given Mumford et al.'s (1991) model. On the other hand, even the evidence available at this juncture points to the substantial practical value of further research along these lines. Many of those interested in creativity research are interested because creativity research provides a basis for the assessment of creative potential. Traditionally, we have assessed creative potential through the use of divergent thinking measures (Silvia, Beaty, & Nusbaum, 2013). However, effective process execution has a large, and more direct, impact on creative performance than divergent thinking ability (Vincent et al., 2002). Thus, there would seem to be value, substantial value, in assessing peoples' creative potential vis-à-vis their skill in executing those key creative thinking processes of critical importance in the domain at hand (Mumford, Vessey, & Barrett, 2008; Vessey & Mumford, 2012). For example, in assessing the creative potential of engineers, perhaps we should give them parts and ask them to combine and reorganize these parts to produce a new machine design (Finke, Ward, & Smith, 1992). Alternatively, we might present people with information bearing on a creative problem and ask them to identify relevant anomalies (Mumford, Baughman, & Sager, 2003). Although other examples of this sort might be provided, the foregoing seems sufficient to make our key point. Mumford et al.'s (1991) model of creative thinking processes points to a host of new measures that might be used to assess creative potential.

Not only is this model of value in developing new measures for the assessment of creative potential, it also points to some new ways for developing peoples' creative capacity. Scott et al. (2004) found that the most effective creativity training programs were those which used instruction, and exercises, expressly intended to develop these key creative thinking processes. Indeed, other work by Marcy and Mumford (2007) and Osburn and Mumford (2006) has demonstrated the value of providing instruction contributing to more effective execution of the specific operations held to underlie application of certain creative thinking process. Thus, by focusing on the specific creative thinking processes identified by Mumford et al. (1991), we may develop a sounder, and more robust, set of educational interventions contributing to peoples' ability to solve the kind of complex, novel, ill-defined problems that call for creative thought.

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