Task difficulty and team diversity on team creativity: Multi-agent simulation approach

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ABSTRACT

Organizational structures are complex and vary according to sector, field, and type of business or service. In order to be effective, an organization needs to tailor its activities to the environment in which is it located. Based on contingency perspectives, this study is focused on investigating effective ways to design team diversity and maximize team creativity according to task difficulty levels. Considering the organizational team member as an agent, the study employed a multi-agent simulation method to understand the progress of creative manifestation, by observing the exploration and exploitation activity of team members over certain periods of time. The results first reveal that the level of team diversity influences the amount of creativity manifested by team members' activities, such as exploration and exploitation. Second, managers have to properly facilitate either exploration or exploitation depending on task difficulty by striking a balance between them.

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1. Introduction

Long-term organizational success depends upon the balance between exploration and exploitation (Chang & Harrington, 2006; Jansen, Bosch, & Volberda, 2006). From an organizational perspective, it is best to maximize both, but this is difficult to achieve simultaneously with limited resources. Therefore, it is important to strike a balance between the two activities according to the organization's environment (March, 1991); however, finding the point of equilibrium that can maximize creativity and productivity is challenging. This is because balance can be interpreted very subjectively according to individual organizational circumstances. Above all, the balance needs to be appropriate to the situation. According to the contingency theory, "there is no single organizational structure that is highly effective for all organizations" (Donaldson, 1996, p. 57). Therefore, an optimal structure is dependent upon various contingency factors, such as task uncertainty, strategy, and technology, which reflect the influence of the environment. Specifically, the organization needs to fit its activities to the environment in which the organization is located to be effective (Donaldson, 1996). In this sense, task-solving processes are generally influenced by both the characteristics of

the task itself and by the organizations that solve the task. Accordingly, this study focused on examining existing research and determining how to establish proper strategies for situation-appropriate exploration and exploitation activities. The aim is to maximize team performance by taking into consideration task difficulty as a situational factor and team diversity as an organizational characteristic. In particular, the study applied an agent-based simulation method to understand the progress of creative manifestation through exploration and exploitation activities by team members according to the passage of time. The objectives of the study are as follows: to investigate how task difficulty and team diversity affect a team's task-solving processes in terms of the team members' exploration and exploitation behavior, and, in turn, team performance; to identify effective ways of designing team diversity according to task difficulty; and to find strategies for striking a balance between exploration and exploitation that can maximize team creativity in any given circumstance.

2. Literature review

2.1. Task difficulty

Task difficulty is referred to as the level of activity that requires a significant amount of cognitive or physical effort to develop the learner's knowledge and skill levels (Van Velsor & McCauley,

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2004). When the task difficulty is high, an individual faces a task or a situation in which he or she needs to use knowledge, skills, and behaviors at a level higher than his or her current level of competence. In addition, it has been found that individuals are not motivated by a task whose success or failure is certain, but rather by a task in which the rate of success is predicted at an average level and has a serious sense of challenge (Malone & Lepper, 1987). Determining the task difficulty is not only necessary when designing and developing a task, but it is also important when evaluating the task results.

Many studies have been conducted to determine the relationship between the effects of task difficulty and performance. Marshall and Brown (2004) posit that task difficulty plays an important role in the relationship between expected and actual performances. Furthermore, the authors insist that expected performance has a positive effect on actual performance only if the task difficulty is high. If task difficulty is high, continuity is requested of a performer, but if task difficulty is low, a task can be easily resolved without a high level of continuity (Marshall & Brown, 2004). In addition, Brehm, Wright, Solomon, Silka, and Greenberg (1983) explain that unless a task is extremely difficult or impossible to resolve, a high level of effort can lead to a high level of performance. This notion is based on an achievement motivation theory put forward by McClelland, Atkinson, Clark, and Lowell (1953). According to this theory, performers with high resultant achievement motivation tend to establish realistic goals and to prefer tasks with appropriate task difficulty, where uncertainty can be optimized. In the meantime, performers with low resultant achievement motivation tend to prefer very easy or very difficult tasks to minimize uncertainty about success or failure (McClelland et al., 1953). As a result, performers with high resultant achievement motivation put a high level of effort into achieving higher performances than those with low resultant achievement motivation.

Meanwhile, there are some studies on the relationships between exploration and exploitation and other factors, such as task difficulty, environmental stability, and pursuing goals with different time limits. In a new product development (NPD) environment, where competition is intensified, and it is difficult to achieve success, the focus needs to be on the exploitation activity; however, it has also been argued that exploration is needed to resolve long-term problems (Garcia, Calantone, & Levine, 2003). Analysis conducted by a private research and development (R&D) center found that exploitation is pursued to attain short-term goals, while exploration is pushed in order to introduce new technology in the long term (Cesaroni, Minin, & Piccaluga, 2005). In addition, in a very stable environment, it is appropriate that exploitation innovation targets existing customers and markets and that existing technologies are used. On the contrary, in very unstable circumstances, it is appropriate that exploration innovation targets new customers and markets, and that new technologies are created and developed (Benner & Tushman, 2003).

2.2. Diversity

Diversity is defined as "differences between individuals on any attribute that may lead to the perception that another person is different from self" (Van Knippenberg, De Dreu, & Homan, 2004, p. 1008). Previous research on the relationship between team diversity and performance include both positive and negative effect relationships (Jehn, Northcraft, & Neale, 1999; Page, 2007; Riordan & Shore, 1997; Taylor & Greve, 2006). Further, it relates to the two traditions of research on team diversity and performance (Williams & O'Reilly, 1998): the social categorization perspective and the information/decision-making perspective. The social categorization perspective suggests that team members generate social categories based on similarities and differences among them, preferring to interact with members in their own category over members perceived to be in "foreign" categories (Brewer, 1979; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987). Members of homogeneous groups tend to communicate with one another more frequently and in a greater variety of ways. This is due to the fact that they share worldviews and a unified culture originating from in-group attachments and shared perceptions (Earley & Mosakowski, 2000). According to social identity theory, homogeneity increases satisfaction and cooperation while reducing emotional conflict (Tajfel & Turner, 1985; Williams & O'Reilly, 1998). Since homogeneous groups do not have critical cultural barriers to social intercourse, an environment encouraging positive social associations and in-group social contact is created (Blau, 1977). Some studies argue that a homogeneous team can achieve more than a diversified team (Jehn et al., 1999; Riordan & Shore, 1997). In accordance with views presented in existing studies, a team with excessive diversity might cause coordination problems, resulting in fewer achievements.

In contrast, the information/decision-making perspective maintains that teams with diversity should outperform homogeneous teams. This is based on the belief that diversity will lead to possession of a broader range of task-relevant knowledge, skills, and abilities that are distinct and non-redundant. Researches insisting that team diversity has a positive effect on team performance emphasize an organizational synergy effect generated by team members' diversity through interactions (Kim & Rhee, 2009; Page, 2007; Taylor & Greve, 2006). Based on those studies, diversities that mainly affect team performance include tenure and knowledge. According to various studies on the relationship between demographic diversity and team performance, a team with tenure-structured diversity can own social capital because of long-established and diversified human relationships inside and outside of an organization, along with the existence of diverse technologies, information and experiences, leading to improved team creativity (Pelled, Eisenhardt, & Xin, 1999). In particular, Taylor and Greve (2006) insist that if a team enters a diversified knowledge domain, it can use this combination of knowledge to create innovation. Tiwana and McLean (2005) show that if a team is formed by members with diverse knowledge, technologies and competencies, its competence and performance can be improved along with team creativity. Regarding the relationship between a creative manifestation process (exploration and exploitation) and diversity, existing studies insist that diversity can have a positive effect on the creative manifestation process. McGrath (2001) argues that diversity is important for developing new technologies, creating new business practices, and exploring new products.

2.3. The categorization–elaboration model

Recent perspectives acknowledge the coexistence of both informational and social/categorical group responses to diversity. Van Knippenberg, De Dreu, and Homan (2004) suggest two factors, elaboration and categorization, as key factors for approaching diversity from the perspective of improving workgroup performance. Elaboration is related to the group's collective process of combining and improving upon discrete viewpoints held by its members to generate outcomes that are more informed, creative, and otherwise superior to what could be probably produced by each member working alone. In contrast, categorization refers to the process of social categorization and the associated presence of inter-group bias. Social categorization implies the tendency of groups of individuals to form group mental models, whereby some members belong to the 'in-category,' and others are the 'out-category' in relation to themselves (Van Knippenberg, De Dreu, and