Chapter 13
Collaborative Technology and Dimensions of Team Cognition:
Test of a Second-Order Factor Model

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ABSTRACT

The purpose of this study was to explore team cognition as a multidimensional activity comprised of team learning, team reflexivity, and team mental model during project teamwork. A laboratory experiment was conducted to examine the effects of two different modes of collaboration – face-to-face and technology-mediated collaboration on team cognition and its subsequent impact on task outcomes. Team cognition was represented as a second-order construct comprised of three first-order dimensions. A direct-observation rating scale used to derive measures of the first-order dimensions was shown to have strong psychometric properties. The partial least squares method was used to test a structural equation model where the second-order construct was presented as a mediator between collaboration mode and task outcomes (productivity and interaction quality). As hypothesized, team cognition significantly influenced productivity and interaction quality outcomes. Further, collaboration mode significantly improved team cognition through its specific effects on the team learning, team reflexivity, and team mental model development. The main contribution of the study lies in its finding that team cognition can be viewed as a hierarchical construct that accounts for distinct yet cognition-related behaviors. This finding offers an extension to current related research models and identifies behavioral indicators that can be monitored by project managers in developing prescriptive measures aimed at promoting project success.

INTRODUCTION

A principal factor underlying the increased use of project teams in organizations is the recognition that teams are especially proficient in responding to dynamic and complex situations (e.g., Burke, Stagl, Salas, Pierce, & Kendall, 2006). Team cognition is the mechanism by which project teams are able to collectively apply individual knowledge and skills toward task strategy development and task execution

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(Kozlowski & Ilgen, 2006). More specifically, team cognition refers to the synthesis of information exchanged into an ordered set of knowledge structures of the task context as well as the ways in which the team validate and use these knowledge structures. These knowledge structures are often referred to as mental models. Recent studies have noted a connection between shared mental model and team effectiveness (e.g., Lim & Klein, 2006; Xie, Zhu, & Wang, 2009). These studies support the idea that mental models are used to make inferences regarding task goal progress and subsequent actions needed to address the current task status and organizational environment. A number of studies have investigated the impact of various structural configurations among team learning, shared mental model and team reflection along with other associated variables on collaborative work outcomes (e.g., De Dreu, 2007; Lewis, Lange, & Gillis, 2005; Salas, Cooke, & Rosen, 2008; van Ginkel, Tindale, & van Knippenberg, 2009; Xie, Zhu, & Wang, 2009).

In this study, it is argued that team cognition is a multidimensional activity comprised of *knowledge acquisition, knowledge synthesis, and interpersonal interaction* behaviors that are enacted during team-based problem solving. To this date, no known published empirical research on IT project management has used this specific perspective to assess the potential multidimensional structure of team cognition. From a theoretical standpoint, higher order constructs allow for the testing of constructs at multiple levels, promote theoretical parsimony, and reduce model complexity (Edwards, 2001). From a practical standpoint, decomposition of multidimensional constructs offer identification of more points of leverage for managers to design prescriptive practices at both broad and narrow levels of analysis. It could also help design normative practices that promote team learning, team reflexivity, and team mental model development during project teamwork.

Accordingly, the objective of this study was to develop and test a model that specifies a multidimensional structure of team cognition. The model draws from the theories of *team-based learning* (Edmondson, 1999; Edmondson, Dillon, & Roloff, 2007; Hirst, van Knippenberg, & Zhou, 2009), *team reflexivity* (De Dreu, 2007), and *team mental model* (Cooke et al., 2003). A secondary objective of the study was to test the role team cognition as a mediating influence in the impact of collaboration mode on team-based problem solving outcomes – productivity and interaction quality. The next section discusses the theoretical support and hypotheses regarding the multidimensional structure of team cognition. This is followed by a description of the research methodology and presentation of empirical results. Then the results, contributions, and limitations are discussed.

LITERATURE REVIEW, HYPOTHESES, AND RESEARCH MODEL

Project-based work such as large scale software development is typically conducted using a formal development methodology comprised of 1) requirements/problem analysis, 2) solution design, 3) implementation (database/program coding), and 4) deployment activities (Balijepally, Mahapatra, Nerur, & Price, 2009). The team learning process, via peer interactions, is conducted in order to perform requirements analysis needed to acquire a shared mental model that represents the problem domain which subsequently facilitates the design of alternative solutions (Khatri, Vessey, Ram, & Ramesh, 2006). During the software development activities, metacognition (i.e. reflective assessment of one's own thinking and actions) is used to monitor and guide the task execution (He, Butler, & King, 2007). The next section presents a theoretical framework for conceptualizing team cognition as a multidimensional construct comprised of team learning, team reflexivity and team mental model.