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SENSEMAKING AND LEADER CREATIVE PERFORMANCE: THE EFFECT OF UNDERSTANDING STAKEHOLDERS' MENTAL MODELS

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Abstract

Organizational leaders are often presented with novel, complex, and ill-defined problems that call for creative problem-solving. Furthermore, the socially embedded nature of leadership problems requires that leaders develop solutions in light of the needs, concerns, and perspectives of key organizational stakeholders. Put differently, to solve creative problems leaders must engage in effective sensemaking to understand the mental models of stakeholders. However, little research has investigated the impact of understanding stakeholders' mental models on the creative performance of leaders. In this study, participants were asked to generate a solution to an educational problem. Prior to solution generation, however, they were presented with case information about three stakeholders and were asked to depict the mental model of each stakeholder. Findings indicated that a more accurate understanding of stakeholders' mental models resulted in enhanced performance across multiple creative criteria. Additionally, it was found the successful execution of various cognitive sensemaking strategies was related to a more accurate understanding of stakeholders' mental models. The implications of these findings for understanding and enhancing leadership performance in organizations are discussed.

Introduction

Of the variety of meta-models often employed in studies of leadership (Zaccaro, 2014), scholars have argued that the study of leaders as complex problem-solvers has received the least attention (Mumford, Todd, et al., 2017; Zaccaro & Klimoski, 2001). However, with organizational environments often characterized as dynamic, complex, and uncertain, many scholars have noted that leaders of modern organizations face increasingly complex problems that call for a variety of problem-solving skills for effective leadership performance (Day, 2013; Day & Halpin, 2004; Mumford, Todd, et al., 2017). More specifically, the nature of these problems lends support to creative problem-solving as an essential skill for organizational leaders. Creative problem-solving, defined as the development of high quality, original, and elegant solutions to novel, complex, and ill-defined problems (Besemer & O'Quin, 1999; Mumford & Gustafson, 1988), has been linked to leadership across multiple studies (Connelly et al., 2000; IBM, 2010; Mumford, Marks et al., 2000; Puccio et al., 2017).

Though leaders are often confronted with novel, complex, and ill-defined problems, it is important to note that problems in leadership domains are inherently social in nature (Fleishman et al., 1991; Mumford & Connelly, 1991; Mumford, Zaccaro et al., 2000). According to sociotechnical systems theory, organizational leadership roles exist for the functional purpose of supplying, directing, and coordinating a network of organizational subsystems toward a collective purpose (Katz & Kahn, 1978; Zaccaro & Torres, 2020). The integrated nature of these subsystems implies that effective leader problem-solving occurs in response to the contextual demands arising from these various subsystems and their interconnected stakeholders (Hoojiberg & Schneider, 2001; Mumford, 1986; Zaccaro & Torres, 2020). These conditions enhance the complexity of leadership problems and require that leaders develop solutions in light of the social dynamics bearing on the problem at hand (e.g., stakeholder perspectives, effects on stakeholders) (Geiwitz, 1993; Mumford & Connelly, 1991; Zaccaro & Torres, 2020).

Given the socially embedded complexity of these problems, a leader's effective engagement in sensemaking to understand the needs, concerns, and perspectives of organizational stakeholders is critical for creative problem-solving (Medeiros et al., 2020). Effective sensemaking allows leaders, through a process of information gathering and interpretation, to develop more comprehensive mental models representing information relevant to organizational stakeholders (Marcy & Mumford, 2010; Weick, 1995). In turn, these mental models, or cognitive frameworks of knowledge, can serve to inform the generation of more creative solutions to these socially complex problems (Tam et al., 2020). However, some scholars have argued understanding the needs, concerns, and perspectives of stakeholders requires that leaders engage in perspective taking to understand the mental models stakeholders apply to given problem domain (Maitlis, 2005; Marcy & Mumford, 2010; Sonenshein, 2007; Werhane, 1998, 1999, 2008).

Nevertheless, research examining the effect of understanding stakeholders' mental models on leader creative performance is lacking. In fact, given mental models represent cognitive knowledge structures, studies on problem-solving and performance have been predominantly confined to the mental models of individuals or the effects emerging from individual's mental models (e.g., shared mental models) (DeChurch & Mesmer-Magnus, 2010b; Mumford et al., 2012). Thus, the present study makes a significant and novel contribution to the literature as it examines the capacity for leaders to understand the mental models of others, in this case, stakeholders, and how this understanding influences their subsequent creative performance. In addition, this study attempted to examine the potential for various cognitive sensemaking strategies to enhance a leader's capacity to understand the mental models of stakeholders.

Leader Sensemaking

Sensemaking is a complex cognitive process whereby leaders make meaning of their environment for the purpose of developing a framework, or mental model, for understanding and responding to a given situation (Bagdasarov et al., 2016; Thomas et al., 1993; Weick, 1995). Put differently, leaders engage in sensemaking in an attempt to understand novel, complex, and ill-defined problems or circumstances. The sensemaking process is often held to occur through dynamic engagement in environmental scanning, information interpretation and integration, and action (Mumford et al., 2007; Thiel et al., 2016; Thomas et al., 1993). As environmental cues that denote novelty and complexity emerge and are recognized, leaders scan the internal and external environment to gather and interpret environmental information in relation to their conceptual and experiential knowledge (Choo et al., 2008; Strange & Mumford 2005). This process allows leaders to integrate information to construct mental models that delineate key goals and causes operating in complex problem domains (Caughron, Antes et al., 2011; Mumford, Higgs et al., 2020). As a result, these models allow for reduced uncertainty and clarification regarding optimal courses of action (Caughron et al., 2020; Hahn et al., 2014; Jameson, 2009; Maitlis & Christianson, 2014; Tam et al., 2020).

Sensemaking is a foundational process contributing to a leader's execution of creative problem-solving processes. Leaders are expected to solve problems in which they have minimal prior experience (i.e., novelty) and where a host of environmental variables interact to comprise a network of cause and effect relationships (i.e., complexity) (Caughron et al., 2020; Halbeslen et al., 2003). Additionally, and as noted earlier, the socially embedded nature of these problems requires that problem solutions be appraised for appropriateness within the given social context (Mumford & Connelly, 2000). More specifically, consideration of the perspectives, needs, functions, and expertise of various constituencies and stakeholders will prove important in the generation and implementation of solutions. These observations imply that the rote application of extant knowledge structures (i.e., mental models) is likely insufficient for solving the problems leaders often confront (Mumford & Martin, 2020; Mumford & Connelly, 1991). Instead, leaders must engage in an ongoing process of revising, combining, and reorganizing these mental models, via sensemaking processes, to construct mental models that are more representative of the emerging problem (Caughron et al., 2020; Maitlis & Christianson, 2014; Weick, 1995).

As a result, sensemaking has been shown to be important for complex problem-solving, decision making, and creativity across multiple studies. For example, sensemaking has been shown to facilitate ethical decision making (Thiel et al., 2016). Like creative problems, ethical problems are often characterized by complexity and ambiguity, where decision alternatives can have large, and often conflicting, implications for multiple stakeholders (Werhane, 2002; Zeni et al., 2016). Moreover, both Bagdasarov et al. (2016) and Caughron et al. (2011), in studies presenting participants with ethical scenarios, have provided evidence that sensemaking processes such as analysis of causes, identification of constraints, and information integration are positively related to ethical decision making.

Studies by Dougherty et al. (2000), Jay (2013), and Drazin et al. (1999) have provided evidence for sensemaking as a driving force of creativity and innovation in organizations (Maitlis & Christianson, 2014). More specifically, Drazin et al. (1999) found that a large corporation's capacity to develop a new technology (i.e., an airplane) was largely determined by its leaders' engagement in sensemaking activities in response to emerging crises. Moreover, Dougherty et al. (2000) found that more or less innovative firms differed with respect to sensemaking activities, in which innovative firms promoted shared understandings of organizational goals and processes and frequent interaction to collectively understand emerging issues (Maitlis & Christianson, 2014). These observations, in turn, demonstrate that sensemaking is a cognitive process critical to solving the novel, complex, ill-defined, and socially embedded problems often confronting organizational leaders. Ultimately, effective sensemaking allows leaders to construct plausible mental models representing key goals, causes, and social dynamics that inform future action (Tam et al., 2020; Weick et al., 2005).

Mental Models and Leadership

The origin of mental models can be linked to the fields of cognition and system dynamics. Though definitions of mental models may slightly differ based on the domain in which they are being applied, a mental model is generally understood as an internal representation of one's knowledge and perception of a domain-specific system (Paoletti et al., 2020). More specifically, mental models are cognitive structures representing interrelated components of knowledge, organized into a series of cause-goal linkages (Goldvarg & Johnson-Laird, 2001; Lim & Klein, 2006; Rouse & Morris, 1986; Webber et al., 2000). This organized representation of knowledge is a framework that allows individuals to describe the purpose of a specific system, explain how the system operates, and predict future system states (Rouse & Morris, 1986; Werhane, 2000). Put differently, in the domain of organizational psychology, mental models can be generally conceptualized as work-related knowledge structures representing one's understanding of how interrelated causes affect various work outcomes.

Mental models are developed through experience (Paoletti et al., 2020), As a result, mental models are dynamic, subjective, and incomplete structures that are revised and enhanced as an individual acquires new information from their environment. Accordingly, research has demonstrated that mental models vary in accuracy, coherence, and complexity as a function of experience, performance, and personal perspective (Werhane, 2008; McKeithen et al., 1981; Hmelo-Silver & Pfeffer, 2004). These variations demonstrate noteworthy implications, as mental models form the basis for human processes such as judgment, reasoning, and problem-solving (Doyle & Ford, 1998; Goldvarg & Johnson-Laird, 2001). Moreover, research has shown the quality of mental models is related to more effective decision-making and performance (Kraiger et al., 1995; Rowe & Cooke, 1995; Lim & Klein, 2006; DiBello et al., 2011).

These observations also demonstrate important implications for sensemaking. As mentioned previously, leaders must engage in effective sensemaking to construct viable mental models representing the complex problem environments in which they operate (Weick, 1995; Strange & Mumford, 2002). This process is ultimately rooted in mental models (Mumford et al., 2007). When leaders first attempt to understand the problem environment, they apply a descriptive mental model delineating the typical causes and goals operating in the given domain (Strange & Mumford, 2005). This model is used to guide the sensemaking processes of information gathering and interpretation (Caughron et al., 2020, Tam et al., 2020), allowing leaders to further manipulate and revise this descriptive mental model to form a prescriptive mental model. This prescriptive mental model then serves to represent a more ideal framework of the given problem environment (Mumford, 2006; Strange & Mumford, 2005).

This sensemaking process is ongoing and allows leaders to refine and develop a more comprehensive mental model of the performance domain (Strange and Mumford, 2005; Weick, 1995). In turn, these mental models guide a leader's decision making and problem-solving performance in numerous ways. For example, leaders use these prescriptive mental models to articulate a shared vision for the organization, or a unified image of the future (Paoletti et al., 2020). A shared vision has been shown to influence multiple positive outcomes, including follower motivation and effective group interaction (Parry & Proctor Thompson, 2001; Sosik et al., 1999). Similarly, a leader's mental model is an important facilitator of shared mental models in teams (Benson, 2016; Paoletti et al., 2020). Shared mental models can improve team effectiveness by reducing the need for explicit communication, enhancing task-related processes like coordination, planning, and goal setting, and positively influencing the motivational states of team members (Dechurch & Mesmer-Magnus, 2010a; Lim & Klein, 2006). Finally, multiple studies have provided evidence that mental models play a significant role in facilitating creative problem-solving (Anderson et al., 2006; Mumford et al., 2012; Shah et al., 2001).

Leader Sensemaking and Stakeholder Mental Models

The previously discussed propositions and findings emphasize two key points. First, mental models are fundamental to effective leadership performance as they influence a variety of leadership performance outcomes, including creative problem-solving. Second, when leaders are presented with these novel, complex, and ill-defined problems, sensemaking is a mechanism by which leaders develop these mental models to understand the relationships operating in the problem domain and inform problem solutions. However, the capacity for leaders to generate effective problem solutions is dependent on the viability of these mental models, or the extent to which they adequately represent and explain relevant aspects of the problem domain (Thiel et al., 2012). Therefore, given that complex problems in leadership domains are inherently social, many scholars have argued the construction of viable mental models in leadership domains is dependent on the leader's ability to make sense of the social information bearing on the problem at hand (Geiwitz, 1993; Zaccaro, Gilbert et al.,1991; Zaccaro & Torres, 2020).

In line with these propositions, the consideration of organizational stakeholders in solution generation and implementation is seen as an important element of leadership performance (Schneider, 2002; Day, 2001). Moreover, the nature of organizations ensures the complexity of leader problem-solving efforts as stakeholders embedded in organizational subsystems often carry different needs, concerns, and perspectives (Day, 2001; Katz & Kahn, 1978; Neville & Menguc, 2006; Zaccaro & Torres, 2020). This complexity requires leaders to effectively engage in sensemaking with respect to stakeholder relevant information which, in turn, may allow leaders to identify more plausible courses of action in light of these different needs, concerns, and perspectives.

These observations are similar to propositions made by many other leadership scholars (Hoojiberg & Schneider, 2001; Mumford et al., 2000). Zaccaro and Torres (2020) argued that effective problem-solving requires social acuity, or the capacity for leaders to "perceive, interpret, and factor social dynamics into their problem meaning-making and solution generation/evaluation processes" (p. 307). Mumford, Zaccaro et al. (2000) and Tam et al. (2020) identify social judgment skills as critical to leadership as solutions to complex problems must be effectively integrated with the demands arising from the social environment. This can include skills such as social perceptiveness, or gaining "insight into the needs, goals, demands, and problems of different organizational constituencies (Mumford, Zaccaro et al., 2000, p. 19; Zaccaro, Gilbert et al., 1991). Furthermore, it involves being aware of how well solutions are integrated with the "different concerns, responsibilities, and functions" of various constituencies and stakeholders (Mumford, Zaccaro et al., 2000, p. 19).

These points further emphasize that to generate creative solutions to complex problems, solutions that effectively fit within the broader social and organizational environment, leaders must engage in sensemaking to understand the concerns and perspectives of key stakeholders (Day et al., 2020; Kuhnert & Russell, 1990; Mumford, Zaccaro et al., 2000; Tam et al., 2020). More specifically, they must seek to understand how stakeholders perceive the interrelated elements operating within the problem domain (Zaccaro & Torres, 2020). These points demonstrate an important implication. Namely, understanding the concerns and perspectives of stakeholders ultimately requires that leaders engage in perspective taking to understand the mental models of stakeholders (Marcy & Mumford, 2010; Sonenshein, 2007; Werhane, 1998).

Despite these observations, there is minimal, if any, research evaluating the implications of understanding stakeholders' mental models on leader creative performance. However, this is likely to contribute to leader creative problem-solving in numerous ways. As leaders develop a more accurate understanding of stakeholders' mental models, they are likely to perceive problems more objectively, a capacity deemed necessary for complex and ambiguous problems involving multiple systems and stakeholders (Mumford, Zaccaro et al., 2000). Additionally, seeking to understand stakeholders' mental models may likely allow for more effective integration of information relevant to the problem domain (Thiel et al., 2012). This integration process is important for sensemaking and should allow leaders to develop a more comprehensive model representing the social complexities of the problem (Sonenshein, 2007; Theil et al., 2012). In turn, they are able to more effectively predict the social implications of various actions in order to identify optimal problem solutions (Thiel et al., 2012; Zaccaro, Gilbert et al., 1991; Zaccaro & Torres, 2020). Taken together, these observations suggest that understanding the mental models of stakeholders is likely to contribute to more effective sensemaking and enhanced leader creative problem-solving performance. In addition, these solutions are likely to be more effectively integrated with concerns and perspectives of stakeholders.

H1: The extent to which participants understand the mental models of stakeholders will positively influence the quality, originality, and elegance of their problem solutions.

H2: The extent to which participants understand the mental models of stakeholders will positively influence the extent to which their problem solutions address the concerns of stakeholders.

Cognitive Strategies

The proposition that understanding the mental models of stakeholders will enhance the creative performance of leaders broaches additional questions worthy of consideration. Most notably, these performance benefits are contingent on the leader's capacity to generate an accurate understanding of stakeholders' mental models. As noted previously, developing this understanding will ultimately be facilitated through the effective execution of sensemaking processes. However, the complex and cognitively demanding nature of the sensemaking process implies it can be executed more or less effectively dependent on a variety of cognitive factors (e.g., personal bias, self-reflection) (Sonenshein, 2007; Thiel et al., 2012). Thus, it is relevant to examine cognitive strategies that might enhance a leader's capacity to effectively engage in sensemaking to understand the mental models of stakeholders.

Analogical Reasoning

Analogies are commonly used for the purpose of comprehending complex, novel, or abstract phenomena (Bulgren et al., 2000; Jaeger et al., 2016). Analogies allow for individuals, through a process of non-literal comparison, to draw on their existing conceptual or experiential knowledge (i.e., source domain) to generate inferences about a new domain (i.e., target domain) (Zook, 1991). Underlying the use of analogies is a collection of mental operations that, when enacted, comprise what is referred to as analogical reasoning (Mumford & Martin, 2020). Analogical reasoning primarily involves a process of mapping and inference between the source and target domains (Jaeger, 2016; Mumford & Martin, 2020). Mapping involves comparison of the source and target domains to identify correspondences and is the mechanism by which source domain knowledge is used to draw inferences about the target domain (Gentner, 1983). However, according to Gentner's structure-mapping theory (1983), these correspondences refer not to literal shared attributes, but to similarities in the relational structure of the source and target domains (Gentner, 1983; Holyoak & Thagard, 1997). This specification is noteworthy as it explains analogical reasoning is a process ultimately rooted in mental models (Gentner, 1983; Jaeger, 2016). Moreover, the end product associated with analogical reasoning is a mental model representing the target domain as inferred from a model of a more familiar domain.

Analogical reasoning has been shown to influence both problem-solving and learning. For example, a series of studies by Baughman and Mumford (1995) and Mumford, Baughman, et al. (1997) examined the cognitive processes underlying conceptual combination—an analogically driven creative process by which concepts are combined or reorganized to inform idea generation. They found processes such as feature mapping and elaboration of those mapped features contributed to both successful conceptual combination and subsequent creative performance. Studies have also shown when individuals are exposed to novel problems, their problem-solving efforts often rely on inferences drawn from similar, albeit, familiar problems or situations (Ross, 1987). Moreover, analogical reasoning has been shown to contribute to the comprehension of novel information, especially information that is highly spatial, such as scientific phenomena (Donnelly et al., 1993; Iding, 1997; Jaeger, 2016)

Taken together, these findings and observations point to the potential contribution of analogical reasoning to understanding the mental models of stakeholders. By nature, mental models are relationally structured, and analogical reasoning provides a means whereby relational structures in novel or complex domains can be inferred based on relationally similar source domains. Thus, when engaging in sensemaking to understand the mental models of stakeholders, use of a relationally similar analogy could prove beneficial. Additionally, it is important to note that the presentation of an analogy is likely to be most beneficial as leaders effectively engage in analogical reasoning processes. Multiple studies have demonstrated that analogical reasoning processes can be executed more or less effectively, subsequently accounting for differential effects on learning and performance (Armour-Thomas & Allen, 1990; Mumford, Baughman et al., 1997; Scott et al., 2005). Thus, it is also likely that effective mapping of shared features, and the extent to which inferences are drawn from elaboration of those mapped features, will be related to one's capacity to accurately understand stakeholders' mental models.

H3a: Prompting participants to use a relevant case analogy will positively affect the extent to which they understand the stakeholders' mental models.

H3b: Feature mapping will be positively related to participants' understanding of the stakeholders' mental models.

H3c: Feature elaboration will be positively related to participants' understanding of the stakeholders' mental models.

Depth of Processing

The concept of processing *depth* or *level* was first introduced in a series of papers by Craik & Lockhart (1972) and Marton and Säljö (1976). Marton and Säljö (1976), in a study asking students to read a passage and answer questions regarding its content, found that differences in learning outcomes could be attributed to qualitative differences in the learning process, or in other words, the way in which students engaged with the content. From this emerged the idea of levels of processing, in which learning approaches can generally be characterized in two ways—deep-level or surface-level.

Surface-level processing is an approach in which the learner directs their focus toward various facts or disconnected concepts (Watkins, 1983). In essence, the learner takes on a rote learning strategy with a goal often associated with reproducibility. Emphasis is placed on surface-level features of the content elements with little consideration for their meaning or interrelationships (Biggs, 1991). Deep-level processing, however, is an approach in which emphasis is placed on the underlying meaning of the material (Craik & Lockhart, 1972; Watkins, 1983). In this case, the learner engages with the content through elaboration and integration by relating material to various contexts, experiences, and prior knowledge. In turn, this allows them to understand the meaning and interrelated nature of content elements (Watkins, 1983).

The depth at which individuals process information has demonstrated important implications for learning and achievement across many studies (Drew & Watkins; 1998; Martin & Säljö, 1976; Zeegers, 2001). For example, Watkins (1983), in a study of Australian undergraduates, found the degree to which students' approaches to studying reflected that of deep-level processing was positively related to their quality of learning. More specifically, deep-level processing resulted in a greater understanding of the interrelated nature of content elements and the abstract principles and ideas emerging from these interrelated elements (Biggs & Collis, 1982; Watkins, 1983). Thus, those who engaged in deep-level processing held more comprehensive mental models representing the content domain.

Given these observations, deep-level processing can be alternatively viewed as a primary facilitator of mental model development. Evidence would suggest, therefore, that the gathering and interpretation of information relevant to stakeholders could be enhanced when accompanied by active, deep-level processing. Consequently, leaders may be able to generate a more plausible understanding of the stakeholders' mental models. Moreover, as with analogical reasoning, it is likely the effective engagement in deep-level processing of socially embedded information will vary as function of different variables (e.g., working memory capacity, motivation, social acuity) (King & Just, 1991; Zaccaro & Torres, 2020), especially in the complex social environments inherent to leadership (Zaccaro & Torres, 2020). As such, leaders may benefit from being prompted to engage in deep-level processing, however, it is also likely the extent to which deep-level processing is effectively executed will be related to their capacity to accurately understand stakeholders' mental models.

H4a: Prompting participants to engage in deep-level processing will positively affect the extent to which they understand the stakeholders' mental models.

H4b: Deep-level processing execution will be positively related to participants' understanding of the stakeholders' mental models.

Forecasting

Forecasting refers to the process of predicting or envisioning how various events will unfold over time (Byrne et al., 2010; Mumford, Fichtel et al., 2020). Forecasting has been shown to be critical for leadership performance as many future-oriented processes and tasks are often embedded in leadership roles (e.g., vision formation, planning) (Hemlin & Olsson, 2017; Strange & Mumford, 2005). In fact, this link has been demonstrated across multiple studies (Byrne et al., 2010; Mulhearn et al., 2020; Shipman et al., 2010). These studies asked participants to forecast the downstream implications of their plans to address a variety of different leadership problems derived from different domains (e.g., education, marketing). They found that forecasting led to higher quality, more original, and more elegant final plans (Mumford, Fichtel et al., 2020). More specifically, Byrne et al. (2010) and Shipman et al. (2010), in an analysis of the attributes of forecasting content, found forecasting extensively (i.e., quantity, variety, and depth of situations considered) and over long timeframes (i.e., consideration of long-term implications) exhibited the greatest effects on the quality, originality, and elegance of participants' final plans.

The contribution of forecasting to creative problem-solving is rooted in mental models (Paoletti et al., 2020). As forecasting involves predictions of cause and effect, mental models form the basis by which forecasting occurs. Moreover, as leaders forecast, they are able to appraise the efficacy of acting on a variety of causes under different environmental assumptions and conditions (Mumford et al., 2007; Mumford, Higgs et al., 2020). Thus, forecasting is often viewed as both an evaluative and sensemaking process, whereby leaders can refine and improve their mental models to more accurately represent the causal system operating in a given problem domain (Dailey & Mumford, 2006; Medeiros et al., 2020; Mumford et al., 2015).

Given these observations, forecasting is likely to play a role in a leader's ability to accurately understand the mental models of stakeholders. In fact, Zaccaro and Torres (2020) discuss the idea of social forecasting or predicting the social implications of various courses of action, including possible responses and reactions of stakeholders. Moreover, these reactions and responses are likely contingent on the stakeholders' perceptions regarding the causes likely to lead to desirable outcomes (i.e., their mental model). Thus, to forecast stakeholders' responses and reactions to potential actions, leaders must actively seek to understand the mental models stakeholders will use to evaluate the efficacy of those actions. Asking participants to forecast these social reactions and responses, therefore, is likely to contribute to a more accurate understanding of stakeholders' mental models. Moreover, like the other cognitive strategies, forecasting is ultimately a skill, and the extent to which it is executed effectively in social domains is likely to vary as a function of things like expertise (Mumford, Fichtel et al., 2020), bias (Buehler & McFarland, 2001), and social acuity (Zaccaro & Torres, 2020). As such, it is also likely that a leader's engagement in forecasting extensively and over long time frames will be related to their capacity to accurately understand stakeholders' mental models.

H5a: Prompting participants to engage in forecasting will positively affect the extent to which they understand the stakeholders' mental models.

H5b: Forecasting extensiveness will be positively related to participants' understanding of the stakeholders' mental models.

H5c: Forecasting timeframe will be positively related to participants' understanding of the stakeholders' mental models.

Of primary interest in the present effort is the effect of these cognitive strategies on understanding the mental models of stakeholders and, in turn, how this understanding contributes to the creative performance of leaders. However, it was also deemed important to explore the potential for these cognitive strategies to exhibit direct effects on creative performance. Perhaps a leader's engagement in these cognitive sensemaking strategies, while contributing to their understanding of stakeholders' mental models, can also serve to directly enhance their execution of various creative processes. For example, in addition to mapping onto a stakeholder's mental model, case analogies may also map directly onto a leader's immediate performance setting and increase the leader's capacity to effectively define the problem. In addition to these direct effects, there is potential for these variables to interact with one another to influence creative performance. For example, the effect of social forecasting on creative performance may be dependent on a leader's capacity to deeply process social information afforded to them by the environment.

RQ1: How might the use of an analogy, depth of processing, and forecasting, along with their corresponding performance dimensions, directly contribute, and be related to, the quality originality, elegance, and stakeholder consideration of participants' plans?

RQ2: How might analogical reasoning, depth of processing, forecasting, and mental model accuracy interact to affect the quality, originality, elegance, and stakeholder consideration of participants' plans?

Method

Sample

The sample was comprised of 211 undergraduate students attending a large southwestern university. The sample contained 150 females and 61 males pursuing a variety of different majors. The mean age of the sample was 18.56 years (*SD* = 1.03). These students were recruited from introductory psychology courses in which they could receive course credit for participating in available research studies. Students reviewed a website containing brief descriptions of various studies and enrolled in those in which they would like to participate. After students completed the study, the experimenter granted approval for the student to receive course credit.

General Procedure

Participants were recruited to participate in a 3-hour study. Participants first completed a battery of timed individual difference measures to act as covariate control variables in the final analyses (e.g., divergent thinking, intelligence, spatial reasoning). After completion of these measures, participants began working on a self-paced instructional program which taught them how to draw and utilize models to solve problems. This training program, explained further in the next section, demonstrates techniques for drawing conceptual maps, or mental models, in a structural modeling framework as illustrated through problems confronting a new manager of a professional football team. This training, moreover, provided the basis whereby participants could depict the mental models of stakeholders in the experimental task. Upon completion of this training, participants then engaged in an educational leadership task developed by Strange and Mumford (2005). This task asked participants to assume the role of principal of a newly developed high school who has been charged with developing a plan to help the school achieve academic excellence. Participants were ultimately asked to develop a written plan for achieving academic excellence, with this plan providing the basis for the appraisal of creative performance.

However, before developing this plan, participants were presented with "emails" from an educational consultant informing them there are three stakeholders relevant for them to consider throughout the development of their plan (e.g., district superintendent, state funding representative, head of the district school board). The educational consultant also asked the participant to review case information relevant to each stakeholder, with this case information being directly mapped onto mental models developed for each stakeholder based on the educational literature. After reading through this case information, the consultant guided the participants through a set of exercises comprising the manipulations of the study (e.g., analogical reasoning, depth of processing, forecasting). These sensemaking exercises, presented in a fixed order, were targeted at helping participants gain a more accurate understanding of the stakeholder case information. Based on this understanding, and the knowledge they gained from the mental model illustration training, participants were subsequently asked by the educational consultant to illustrate the mental model for each of the three stakeholders. Following that, they were asked to develop their written plan to help the school achieve academic excellence. To conclude the study, participants completed another battery of untimed individual difference measures (e.g., personality, expertise, motivation) to serve as additional control variables.

Mental Model Illustration Training

After completing the initial timed covariate control measures, participants were asked to complete the mental model illustration training. This training program was developed by Mumford and colleagues, and prior studies have demonstrated the effectiveness of this program as well as the transfer of this instruction to other problem-solving tasks (Hester et al., 2012; Mumford et al., 2012). This self-paced instructional program consists of four modules, with each subsequent module targeted at helping participants gain a more complex understanding of mental model structure. For a detailed description of these modules, see Hester et al. (2012).

Within this instructional program, participants are asked to assume to the role of general manager of a new professional football team. Participants are presented with concepts involved in sports management (e.g., sponsorship, selection of coaches, selection of team members, profits) and mental models illustrating the relationships between these concepts. Participants are also provided information explaining the meaning of the relationships underlying the mental models. For instance, they are told that lines between concepts indicate causal relationships. As participants progress through the training, additional concepts are introduced, and more complex mental models are presented (e.g., positive and negative relationships, mediators, feedback loops, etc.) (See Figure 1). After each of the first three modules of the training, participants are asked to respond to two questions intended to check their understanding of the learned concepts as well as their ability to draw inferences from the presented models. During the fourth module of the training, participants are presented with two additional concepts and are asked to develop a new mental model that incorporates these concepts into their understanding of sports management.

Experimental Task

After completing the mental model illustration training, participants began working on the creative problem-solving task—an educational leadership task (Strange & Mumford, 2005). This task has been utilized in multiple studies and has been shown to adequately reflect a problem calling for creative thought (Strange & Mumford, 2005). Participants were asked to assume the role of principal of a new experimental high school. They were then presented with background information about the school, including the purpose for developing the school, how the school will be evaluated, and the implications of successful school performance. Upon receiving this background information, participants were told they would need to develop a written plan for helping the school achieve academic excellence. Moreover, they were told their plans should consider elements such as teaching strategies, ideas for improvement, and special programs.

Stakeholder Cases and Mental Models

Prior to developing their written plan to achieve academic excellence, however, participants received an email from an educational consultant informing them of three stakeholders they will be working with and need to consider when developing their plan. These stakeholders were the district superintendent, a state funding representative, and the head of the district school board. These stakeholders were chosen in consideration of the educational literature to represent stakeholders in the education domain with the potential to be invested in the development of a new school. After these stakeholders were chosen, consideration of the educational literature led to a greater understanding of the general nature of these positions with respect to issues bearing on the development of a new school (Beckham & Wills, 2003; Houston, 2003; Vestergen, 2011). This allowed for greater recognition of the concepts likely to be of concern to each stakeholder (e.g., funding, educational resources, faculty development). Additionally, it provided insight into the causal relationships each stakeholder might perceive to be operating to influence future academic achievement. As shown in Figure 2, this allowed for the development of plausible mental models for each stakeholder.

After developing each stakeholder's mental model, the mental models were then embedded within written cases to be provided to participants in the study. The correspondence between the written cases and mental models is demonstrated in Figure 3. These cases were written from the perspective of the stakeholders. Thus, in accordance with their mental models, the stakeholders described the nature of their jobs in relation to their perceptions of the interrelated causes (e.g., resources, curriculum quality) likely to lead to positive student achievement outcomes (e.g., graduation rates, test scores). These cases were provided to the participants by the educational consultant. The consultant informed the participants that she'd received "messages" from each stakeholder and wanted the participants to thoroughly review the information before moving onto the next section of the task. As the information displayed in the stakeholder cases was directly mapped onto the stakeholders' mental models, these cases provided the foundational information by which participants could engage in sensemaking in an attempt to understand and eventually depict the mental models of the stakeholders.

Manipulations

Analogical Reasoning

After being presented with the stakeholder case information, the participants were then asked to engage in the cognitive sensemaking strategies representing the manipulations of the study. The first manipulation was intended to help participants draw inferences about the three stakeholders and their mental models by providing a relevant case analogy. More specifically, participants in this condition received an email from the educational consultant providing an example of a business manager who was tasked with improving the performance of a customer support division within a company that manufactures and distributes basic technological products (e.g., ink printers).

A case analogy involving a customer support manager was chosen to reflect both a job (i.e., general manager) and a domain (i.e., customer support) likely to be more familiar to participants. This was done to ensure the source domain familiarity required to effectively engage in analogical reasoning processes (Gentner & Gentner, 1983). Additionally, analogies are only effective to the extent that the source (e.g., manager) and target (i.e., stakeholders) domains share underlying commonalities in relational structure (Gentner, 1983). Thus, the development of this analogy began with consideration of the stakeholders' mental models. More specifically, examination of the mental models allowed us to identify conceptual and relational themes across the three stakeholders. These themes (e.g., obtaining resources, investment in personnel, contextual factors), in turn, were used to develop a case analogy embedded with general concepts and relationships that were similar to those presented in the stakeholders' cases. This correspondence is more clearly delineated in Table 1. The educational consultant, as noted previously, asked participants to review this case analogy. Then, in accordance with analogical reasoning processes, the consultant asked the participants to discuss, in a few paragraphs, how the concerns of the business manager are similar to the concerns of the stakeholders (i.e., feature mapping) and how this comparison could help them better understand the stakeholders (i.e., elaboration or inference).

Depth of Processing

The second manipulation was intended to induce deep-level processing of the stakeholder case information. In this condition, participants received another email from the educational consultant, in which she described importance of thinking more deeply about the stakeholders and their key concerns. The consultant then asked the participants to once again review the stakeholder cases. The participants were then asked to write a few paragraphs in which they, first, identify all the concerns of each stakeholder, and second, discuss why they think those concerns are important to that respective stakeholder. The first prompt was intended to help participants identify the key concepts present in each stakeholder's case. The second prompt was intended to promote an understanding of the meaning and interrelated nature of these concepts. Consideration of why stakeholders deem these concepts important is likely to facilitate the participants' understanding of the meaning of these concepts and, according to the stakeholder, how they operate in conjunction to promote student achievement.

Forecasting

The third manipulation was a forecasting exercise. This was the final manipulation presented to participants before they were asked to illustrate the mental model of each stakeholder and develop their plan to achieve academic excellence. In this manipulation, participants received another email from the educational consultant. The consultant asked the participants to take a few minutes to think about various things they might include in their eventual plan. They were then told to again think about the stakeholders and their key concerns and, in light of these concerns, thoroughly predict how each stakeholder might react to various elements of their plan. This prompt was worded carefully to ensure that participants understood the requirement to *thoroughly* predict the reactions of *each* stakeholder. Moreover, participants were asked to write a few paragraphs discussing these predictions.

Rated Variables

Ratings for each of the following variables were provided by three trained judges. For each variable, judges were provided with a clear operational definition and a set of rating cues. These rating cues elaborated on the operational definition and indicated attributes to consider when appraising the presence of the given variable. Operational definitions and rating cues for all of the rated variables are shown in Table 2. With the exception of feature mapping (i.e., a sum total), each variable was rated on a five-point benchmark rating scale. Thus, in addition to operational definitions and rating cues, participants were provided with descriptions of the attributes typically evidenced in responses manifesting low, medium, and high scores on the given variable. Moreover, these descriptions were presented with corresponding example responses extracted from the actual data (See Figures 4 and 5).

The rating process was separated into 3 segments (e.g., manipulation exercises, mental model illustrations, educational plans). Prior to providing ratings for each segment, judges were required to attend a 1-2 hour training in which they gained familiarity with the variables and practiced applying the rating scales to various responses. Judges also met frequently throughout the rating process to discuss and reconcile differences in ratings and clarify procedures for applying the rating scales to each variable. Interrater agreement coefficients for each of these variables are shown along the diagonal in Table 3.

Predictors

As previously mentioned, participants were asked to generate responses to each of the cognitive manipulation exercises. These responses provided the basis for which the effectiveness of the execution of these cognitive strategies could be appraised. Thus, responses to the analogical reasoning exercise were rated for engagement in feature mapping (i.e., total number of shared features identified) and feature elaboration or inference. Responses to the depth of processing exercise were given a global rating of processing depth, or the extent to which the response reflected an in-depth analysis and understanding of the stakeholder case information. Lastly, responses to the forecasting exercise were rated for forecasting extensiveness and forecasting timeframe.

After completing the manipulation exercises, the participants were asked to illustrate the mental model of each stakeholder. These illustrations provided the basis for appraising participants' understanding of the stakeholders' mental models. These three mental model illustrations were rated for the extent to which they accurately (e.g., similarity in concepts and relationships) depicted each stakeholder's *true* mental model—the mental models constructed in consideration of the educational literature. Each mental model was rated separately, however, these ratings were aggregated to form a mean mental model accuracy score that was used in the analyses. An example benchmark rating scale for mental model accuracy is shown in Figure 4. As the effect of each of the cognitive strategies on mental model accuracy was also examined, it is of note to mention that mental model accuracy also served as a dependent variable.

Dependent Variables

After participants attempted to depict the mental models of stakeholders, they developed their plan to achieve academic excellence. This plan formed the basis for the appraisal of creative performance. More specifically, plan solutions were rated for quality (i.e., logical, complete, useful), originality (i.e., novel, original, unexpected), and elegance (i.e., flow, refined, well-crafted) as past research has indicated these variables form the primary dimensions of creative performance (Besemer & O'Quinn, 1999; Christiaans, 2002). As an example, the benchmark rating scale for quality is shown in Figure 5. Additionally, judges also rated the extent to which the educational plans considered the concerns of the stakeholders.

Covariates

A variety of covariate control measures were utilized to capture individual differences likely to play a confounding role when assessing performance on the educational leadership task. Internal consistency coefficients for each of these measures are provided along the diagonal in Table 3. Prior to the mental model illustration training, participants completed timed measures of divergent thinking, intelligence, and spatial reasoning. Many studies have demonstrated the significant role of both intelligence and divergent thinking in complex problem-solving performance (Mumford & Gustafson, 1988; Vincent et al., 2002). Thus, to assess divergent thinking, participants completed Merrifield et al.'s (1962) consequences measure. This measure presents participants with five unlikely events ("What would be the results if human life continued on earth without death?"). For each event, participants are given two minutes to list as many possible consequences of the event. This measure was scored for fluency, or average number of ideas generated across the five events.

Intelligence was measured using a verbal reasoning assessment drawn from Ruch and Ruch's (1980) Employee Aptitude Survey. This assessment presents participants with six sets of factual statements. Each set of statements is presented in conjunction with a set of five conclusions, comprising 30 items in total. Participants are given five minutes to indicate, based on the facts provided, whether each conclusion is, true, false, or uncertain. The final timed covariate was a spatial reasoning assessment. Due to the spatial and relational nature of mental models, some evidence would suggest that spatial reasoning ability is likely to play a role in participants' capacity to effectively illustrate mental models (Gentner & Stevens, 1983; Hegarty, 2010; Jaeger et al., 2016). Thus, spatial reasoning ability was measured using the Redrawn Vandenburg & Kuse Mental Rotations Test (MRT-A) (Peters et al., 1995). This measure presents participants with 24 target objects, with each target object having four corresponding objects. Participants are given six minutes to work through each target object and identify, out of the four corresponding objects, the two objects that are rotated versions of the target object.

The remaining covariate measures were untimed and were completed at the conclusion of the study. Participants first completed a general measure of personality. Personality variables, such as openness, have shown to exhibit effects on creative problem-solving (Batey & Furnham, 2006). Additionally, extraversion may be a variable contributing to one's willingness to both collect and engage with social information during problem-solving. Thus, openness and extraversion were both assessed using Goldberg's (1992) 100-item measure. This measure of Big Five personality traits presents participants with 100 self-descriptive words (e.g., imaginative, introspective, talkative, timid). Participants are asked to indicate, on a 9-point scale, how accurately each word describes themselves relative to their peers. Participants then completed a measure of educational expertise, as expertise is another factor shown to consistently influence complex problem-solving performance (Vincent et al., 2002). Educational expertise was measured using a background data measure drawn from Scott et al. (2005). This measure contains six items asking participants about their prior interest and involvement in educational issues ("How often do you think about educational issues?"). The final covariate measure completed by participants was Cacioppo and Petty's (1982) Need for Cognition scale. This scale measures one's motivation for engaging in complex cognitive tasks, as engagement can influence one's capacity to effectively work with information to solve creative problems (Jaussi et al., 2007). This measure is comprised of 18 items asking participants about their typical motivation to engage in cognitive activities ("I really enjoy a task that involves coming up with new solutions to problems").

Analyses

A set of univariate analyses of covariance (ANCOVA) were used to analyze the data. First, mental model accuracy was dichotomized into low and high accuracy groups using a median split. This dichotomized mental model accuracy variable and the manipulation conditions (i.e., cognitive strategies) were then used as independent variables to assess their effect on each of the creative performance criteria. Following that, each of the manipulation conditions were used as independent variables to assess their effect on the continuous variable of mental model accuracy. In each analysis, covariates were only retained when significant at the .05 level.

Results

Mental Model Accuracy and Creative Performance

Table 3 shows the descriptive statistics and correlations among all the variables of interest. Most notably, mental model accuracy was positively related to the quality (r = .34, p < .01) and elegance (r = .19, p < .01) of educational plans. Moreover, mental model accuracy was also positively related to the stakeholder consideration evidenced in the educational plans (r = 33, p < .01). The correlation between mental model accuracy and originality was non-significant (r = .11, p = 11).

Table 4 shows the analysis of covariance results in which the performance criteria were used as dependent variables and dichotomized mental model accuracy (i.e., low/high) was used as a predictor. Similar to the correlational analyses, mental model accuracy was found to exhibit significant main effects on quality, $F(1, 195) = 17.80$, $p < .01$, elegance, $F(1, 195) = 5.01$, $p < .05$, and stakeholder consideration, $F(1, 195) = 8.40$, $p < .01$. The analysis, however, yielded a non-significant main effect of mental model accuracy on originality, $F(1, 194) = 3.28$, $p = .07$. The estimated marginal means for these main effects are shown in Table 5, demonstrating that participants who held a highly accurate understanding of the stakeholders' mental models developed plans of higher quality, elegance, and stakeholder consideration. Taken together, these findings support Hypotheses 1 and 2, indicating that a more accurate understanding of stakeholders' mental models can serve to enhance creative problem-solving as well as the development of solutions that account for the concerns of stakeholders (See Figure 6). Moreover, it is of note to mention that these effect sizes were not trivial, especially with respect to the effect on the quality ($\eta^2 = .08$) of the educational plans.

Cognitive Strategies and Mental Model Accuracy

Table 6 shows the results of the analysis of covariance where the cognitive sensemaking strategies were used to account for the dependent variable of mental model accuracy. The main effect of analogical reasoning was non-significant, $F(1, 202) = .08$, $p = .78$. Presenting an analogy and asking participants to engage in analogical reasoning did not, on average, result in a more accurate understanding of stakeholders' mental models. Thus, Hypothesis 3a was not supported. However, as the correlational analyses in Table 3 indicated, the extent to which participants successfully engaged in both feature mapping ($r = .22$, $p < .05$) and feature elaboration ($r = .20$, $p < .05$) was positively related to mental model accuracy. This demonstrates support for Hypotheses 3b and 3c, demonstrating that those who successfully executed analogical reasoning processes demonstrated a more accurate understanding of stakeholders' mental models.

Contrary to the analogy condition, a significant main effect was obtained for depth of processing, $F(1, 202) = 4.25$, $p < .05$. Surprisingly, an analysis of the estimated marginal means indicated that this effect was negative (See Table 7). On average, those prompted to engage in deep-level processing ($M = 1.943$, $SE = .086$) demonstrated lower mental model accuracy than those who were not ($M = 2.196$, $SE = .087$). Thus, Hypothesis 4a was not supported. However, as with the analogy condition, the correlational results indicated that the extent to which deep-level processing was effectively executed was positively related to mental model accuracy ($r = .21$, $p < .05$). These results demonstrate support for Hypothesis 4b.

A significant main effect was also obtained for forecasting, $F(1, 202) = 7.72$, $p < .01$. Similar to depth of processing, however, this effect was negative (See Table 7). Those prompted to engage in forecasting ($M = 1.900$, $SE = .086$) demonstrated, on average, lower mental model accuracy than those who were not ($M = 2.24$, $SE = .087$). Thus, Hypothesis 5a was not supported. Forecasting extensiveness ($r = 19$, $p = .05$), however, was positively related to mental model accuracy. This demonstrated support for Hypothesis 5b, indicating that those who forecasted extensively also held a more accurate understanding of stakeholders' mental models. Finally, the relationship between forecasting timeframe and mental model accuracy was non-significant ($r = .17$, $p = .08$). Thus, Hypothesis 5c was not supported.

Direct Effects and Interactions

With respect to the research questions, Table 4 shows the main direct effects of the these cognitive sensemaking strategies on each of the performance criteria. Moreover, the estimated marginal means for the significant main effects are shown in Table 5. This analysis yielded two significant main effects on stakeholder consideration. A significant main effect of the analogy on stakeholder consideration was obtained, $F(1, 195) = 4.38$, $p < .05$. Those prompted to engage in analogical reasoning ($M = 2.414$, $SE = .10$) developed educational plans evidencing higher levels of stakeholder consideration than those not prompted to engage in analogical reasoning ($M = 2.109$, $SE = .105$). Moreover, a significant main effect of forecasting on stakeholder consideration was also obtained, $F(1, 195) = 10.58$, $p < .01$. However, the effects of forecasting on stakeholder consideration were negative, with those asked to forecast producing plans of lower stakeholder consideration ($M = 2.025$, $SE = .102$) compared to those who were not ($M = 2.505$, $SE = .088$; $M = 2.498$, $SE = .104$).

Though being prompted to engage in the cognitive strategies did not, on average, exhibit any significant effects on the creative performance criteria, the correlational analyses in Table 3 demonstrated the same pattern of findings observed earlier. More specifically, the successful execution of the cognitive strategies was positively related to multiple creative performance criteria. Feature mapping and elaboration were not significantly related to any creative performance criteria. However, depth of processing was positively related to both the quality ($r = .29$, $p < .01$) and stakeholder consideration ($r = .24$, $p < .05$) of educational plans. Moreover, the most notable pattern was found with forecasting extensiveness and forecasting timeframe, in which they were both positively related to the quality ($r = .34$, $p < .01$; $r = .29$, $p < .01$), elegance ($r = .33$, $p < .01$; $r = .23$, $p < .05$), and stakeholder consideration ($r = .28$, $p < .01$; $r = .26$, $p < .01$) of educational plans. Consistent with the previous findings, no significant relationships between the cognitive strategy execution variables and originality were obtained.

Lastly, Table 4 shows the significant moderating effects on creative performance. The findings demonstrated only one consistent pattern of interactions across the performance criteria. It was found that mental model accuracy significantly moderated the effect of the analogy on both quality, $F(1, 195) = 4.00$, $p < .05$, and elegance, $F(1, 195) = 8.02$, $p < .01$. As shown in Figure 7, high mental model accuracy strengthened the effect of the analogy on each of these criteria, perhaps suggesting the importance of models for effective engagement in analogical reasoning processes.

Discussion

Limitations

It is important to note a few limitations before turning to the broader implications of the present effort. First, the findings of this study may lack ecological validity for a few different reasons. The convenience sample collected was comprised of undergraduate students. Thus, the extent to which these findings can be generalized to leaders in real-world settings could be questioned. Additionally, the findings of this study are based on participants' engagement in a domain-specific, low-fidelity simulation. This paper-based simulation required the participants to engage in discrete, sequential tasks that may not demonstrate high fidelity with respect to social problem-solving in actual leadership roles and settings. For example, participants were presented with discrete stakeholder cases in which the case content was definitively mapped to the stakeholders' mental models. However, the collection and interpretation of relevant stakeholder information in real-world settings is more ambiguous and complex. In addition, Weick (1995) noted that sensemaking is an ongoing process. Leaders continuously attend to, and interpret, environmentally ambiguous social information. Thus, the discrete nature of the present study may restrict its capacity to speak to the ongoing and ambiguous nature of social sensemaking by organizational leaders.

The present study also only sought to examine three stakeholders specific to the education domain. Moreover, as the *true* mental models for these stakeholders were developed somewhat subjectively, they may not comprehensively represent the given stakeholder domains. As a result, it may be important for further research to consider how the effect of understanding stakeholders' mental models on creative performance may change when working with real stakeholders or more comprehensive mental models. Along similar lines, some literature has attempted to examine how leaders appraise the importance of different stakeholders (e.g., stakeholder salience) (Mitchell et al., 1997). Though three different stakeholders were utilized, the present study cannot speak to the process by which this occurs and its subsequent effects on decision-making or problem-solving.

Another limitation to note is that the manipulations were presented in a fixed order. In addition to potential order effects, this may also provide an explanation for patterns emerging from the results. For example, as a three-hour study, fatigue could have been present in participants exposed to more manipulations, perhaps explaining the pattern of negative effects observed in the forecasting condition. Lastly, it is of note to mention that participants were trained to depict mental models using a structural modeling framework. However, there are multiple methods by which mental models can be constructed and assessed (Rowe and Cook, 1995), and the present study does not address how the findings may differ with the use of different methods.

Theoretical Implications

Despite these limitations, the findings of the present effort demonstrate important implications for leader problem-solving. Most notably, the capacity for participants to develop high quality, original, and elegant educational plans was influenced by their understanding of the stakeholders' mental models. This finding provides support for the idea that leaders need to engage in sensemaking to effectively understand and integrate social information specific to organizational stakeholders (Geiwitz, 1993; Zaccaro & Torres, 2020). More specifically, it is critical for leaders to gather and interpret social information in order to understand the mental models of stakeholders to gain insight into their key concerns and perspectives (Hoojiberg & Schneider, 2001; Sonenshein, 2007; Thiel et al., 2012; Werhane, 1998, 2002; Zaccaro & Torres, 2020). Using their understanding of stakeholders' mental models, leaders are likely able to integrate this information to inform the generation of more creative problem solutions.

These findings are not surprising in light of the fact that the problems faced by leaders are often highly complex and socially embedded (Day, 2013; Fleishman et al., 1991; Katz & Kahn, 1978; Mumford & Connelly, 1991; Mumford, Zaccaro et al., 2000; Zaccaro & Klimoski, 2001). Problem solutions generated by leaders have the potential to affect a variety of organizational stakeholders who often carry diverging concerns, interests, and perspectives (Zaccaro & Torres, 2020). Due to this, leadership scholars have often argued that leaders need to effectively process social information to construct a more viable understanding of the problem domain which, in turn, serves to inform the generation of more optimal solutions (Tam et al., 2020; Zaccaro & Torres, 2020). However, to this point, empirical evidence supporting these propositions is limited. As such, this study makes a significant contribution, demonstrating that participants who successfully made sense of social information to understand the stakeholders' mental models were able to develop more optimal solutions, in that their plans were more likely to be of high quality, originality, and elegance. In addition, these solutions were more likely to account for the concerns and perspectives of key stakeholders operating in the problem domain. This is likely to make for solutions that are more integrated within the broader organizational environment and foster support from organizational constituencies and stakeholders (Collier, 2006; Schneider, 2002; Mumford et al., 2000).

Given these benefits to creative problem-solving, it appears clear that seeking to understand the mental models of stakeholders via sensemaking processes is critical for leadership performance (Mumford, Zaccaro et al., 2000; Tam et al., 2020). However, the complexity and difficulty inherent to successfully executing this task leads to another noteworthy implication of the present effort. The results of this study indicate that the cognitive sensemaking strategies of analogical reasoning, deep-level processing, and forecasting might serve to help leaders more effectively understand the mental models of stakeholders. Simply prompting participants to engage in these strategies, however, was found to be ineffective. Prompting participants to engage in analogical reasoning was insufficient, at least in the aggregate, for promoting an accurate understanding of the stakeholders' mental models. Similarly, understanding of the stakeholders' mental models did not generally improve when participants were prompted to engage in deep-level processing or forecasting. It is important to note, however, that effective execution of these cognitive strategies was related to a more accurate understanding of stakeholders' mental models. In the case of analogical reasoning processes, correlational analyses revealed that extensive feature mapping and subsequent elaboration of those features to draw inferences about the stakeholders were both positively related to participants' understanding of the stakeholders' mental models. This pattern also generally held true across the depth of processing and forecasting strategies as well. More specifically, deep-level processing execution and forecasting extensiveness were both positively related to participants' understanding of the stakeholders' mental models.

In accordance with past research, these findings lend some support to the idea that leader sensemaking processes can be executed more or less effectively (Bagdasarov et al., 2016; Sonenshein, 2007; Thiel et al., 2012), subsequently accounting for differential problem-solving and decision-making performance. More centrally, these differences in sensemaking execution may be largely attributed to individual differences in leaders' capacities to successfully execute these cognitive skills. As a result, short-term interventions prompting leaders to engage in these cognitive strategies may demonstrate limited utility. In fact, those who were prompted to engage in deep-level processing and forecasting, on average, held a less accurate understanding of stakeholders' mental models, perhaps due to the cognitive load associated with the presentation of additional novel and complex tasks (van Merriënboer & Sweller, 2005). Instead, these findings perhaps suggest that the efficacy of these cognitive sensemaking strategies may be dependent on the extent to which they are successfully executed. For example, leaders may be encouraged to forecast, but the effects of forecasting on understanding stakeholders' mental models may be dependent on the extensiveness of the leader's forecasting efforts. Likewise, the utilization of an analogy may serve to help leaders so long as they successfully map corresponding features and elaborate on those features. Finally, leaders may need to successfully engage in deep-level processing of the social information afforded to them through interpersonal interactions or the organizational environment. The successful execution of these sensemaking processes, in turn, may allow leaders to more accurately understand the mental models of stakeholders and use this knowledge to inform creative problem-solutions.

This same pattern of findings also emerged from analyzing the direct effects of these cognitive strategies on the performance criteria. In addition to the inconsistent effects of the analogy (i.e., positive) and forecasting (i.e., negative) on stakeholder consideration, prompting engagement in these cognitive strategies also did not generate any positive effects on creative performance. However, the correlational analyses demonstrated the extent to which these strategies were effectively executed, particularly in the case of forecasting, was positively related to creative performance. Participants who forecasted extensively and over longer time frames produced higher quality and more elegant solutions that also accounted for the concerns and perspectives of stakeholders. In fact, much of the literature on creative problem-solving points to forecasting as a key skill in the creative process (Byrne et al., 2012; Shipman et al., 2010). These specific findings, however, lend some support for the importance of social forecasting (Zaccaro & Torres, 2020). Leaders may need to extensively forecast the long-term implications of a variety of actions on stakeholders operating within the problem domain. Doing this may allow leaders to refine their mental models to identify optimal causes to act upon in light of the forecasted implications for stakeholders (Mumford et al., 2020). In consideration of these observations and findings, however, it is important to note the results lending potential support for each of these effects of successful strategy execution are correlational. Thus, conclusions regarding the causal contribution of effective strategy execution on accurately understanding stakeholders' mental models and creative performance should be informed by future research.

Interestingly, no significant effects, experimental or correlational, were obtained for originality. This may not be surprising considering the literature on the nature of these creative performance criteria. More specifically, though creative performance can be viewed, at least in part, as the development of original solutions, creative solutions can also consist of high quality and elegant solutions that are appropriate within the given context. In other words, a leader's creative performance, as shown in the present effort, is dependent on their ability to generate ideas that effectively and practically fit within the organizational environment (Runco & Charles, 1993). Consideration of stakeholders through these cognitive strategies, therefore, more likely lends itself to ensuring the practicality of creative solutions as opposed to generating solutions that are especially novel.

This is also in line with research suggesting the social nature of complex leadership problems requires that leaders generate solutions in light of the practical demands inherent to organizational subsystems and stakeholders (Mumford, Zaccaro et al., 2020). In other words, the complexity inherent to interconnected subsystems and stakeholders ensures the embeddedness of social constraints within the problem domain. Thorough consideration of these social constraints, in turn, may result in high quality and elegant creative solutions while placing restrictions on a leader's ability to generate solutions that are novel or unique. This observation is further supported by the present study, in which participants' consideration of stakeholder concerns in plan generation was negatively related to plan originality (r = -.23). However, future research should seek to better understand the relationship between leader social sensemaking, social constraints, and the generation of creative problem solutions. For example, findings from a study by Medeiros et al. (2014) indicate that the amount of constraints, the type of constraints, and one's willingness to work with those constraints can have differential implications for creative performance. Moreover, a study by Peterson et al. (2013) has provided evidence that training individuals to manage constraints can result in enhanced creative performance. Consideration of these propositions and findings in the context of socially embedded leadership problems could be a valuable avenue for future research.

Practical Implications

Taken together, these findings also demonstrate a few key implications for organizations. Given these demonstrated effects on creative performance, organizational efforts should be targeted at ensuring leaders not only are encouraged to consider the social dynamics bearing on problems by seeking to understand stakeholders' mental models, but also that they have the capacity to do so. Leaders must be able to effectively execute these cognitive strategies in the face of complex, socially embedded problems. However, the findings here demonstrate that the capacity to effectively execute these strategies is not likely to be enhanced through short-term, situationally based interventions. Instead, these cognitive capacities may likely be developed over time as a function of a variety of variables. For example, a vast amount of research demonstrates that expertise can enhance the execution of some of these strategies (Vincent et al., 2002; Gronn, 2020).

Mumford, Fichtel et al. (2020) discuss evidence that expertise contributes to forecasting skill (Brock et al., 2008; Marcy & Mumford, 2007). Additionally, it is unlikely that leaders would be presented with a socially embedded case analogy when attempting to understand a stakeholders' mental model. Instead, analogies are to be derived from source domains comprised of existing social knowledge structures that drive the analogical reasoning process (Abelson, 1976; Baughman & Mumford, 1995; Gilovich, 1981; Read, 1984). In other words, leaders are likely to draw on past cases or knowledge that map onto the existing stakeholders, demonstrating that a sufficient amount of expertise is likely needed to facilitate the analogical reasoning processes of mapping and elaboration. This observation is consistent with the pattern of interactions resulting from the present effort, indicating that the effect of analogical reasoning on creative performance is enhanced when leaders have a more accurate understanding of the stakeholders' mental models. Consistent with research on analogical reasoning, which suggests that the formation of models underlies the analogical reasoning process, this implies that leaders need a at least a sufficient amount of knowledge of stakeholder relevant information to provide meaningful analogical comparisons that inform the problem-solving process.

Organizations should also seek to consider the methods by which their developmental initiatives and programs for leaders might facilitate the acquisition of socially based knowledge and expertise, in addition to skill at executing these various cognitive strategies. For example, action learning initiatives or rotational assignments can provide developing leaders with exposure to different systems and stakeholders of the organization. Moreover, organizations should encourage these developing leaders to actively, and deeply, process the information afforded to them by such experiences (McCauley, 2001). However, it is important to note that we only sought to investigate a few cognitive skills that might be encouraged by organizations to facilitate effective leader sensemaking with regard to stakeholders. Thus, future research could be dedicated to better understanding these ongoing, socially embedded sensemaking processes and the types of developmental experiences or initiatives that serve to help leaders execute them more effectively.

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Table 1

Correspondence Between Stakeholder Themes and Elements of the Case Analogy

	Stakeholder Mental Model Concepts			
Example Stakeholder Themes	District Superintendent	State Funding Representative	Head of District School Board	Case Analogy
Performance Outcomes (1,2)	Student Test Scores Graduation Rates	Student Achievement	Student Achievement	1. Maria works for a small technology company that manufactures and distributes basic ink printers. She was recently promoted to head of the company's customer support division and was tasked with improving the performance of this division. Analyzing the current state of the division, she found that improving the division's performance was dependent on a few key concerns—identifying specific performance outcomes to improve, obtaining the resources needed to achieve those outcomes, enhancing the performance of employees and team leaders, and managing contextual influences on performance.
Resources (1,3)	Securing Funding Obtaining Resources	State Funding Contribution Total School Funding Educational Resources	Available Funding	
Investment in Personnel (1,3)	Faculty and Staff Development	Quality of School Employees	Effectiveness of Policy and Decision Making	2. First, Maria identified key performance outcomes for the division to focus on, which included outcomes such as decreasing customer support complaints, increasing the daily number of resolved customer issues (e.g., product use, maintenance, repair).
Personnel Performance (1,3)	Teaching Effectiveness	Quality of School Employees	Leader Performance Teacher Effectiveness	3. After identifying these performance outcomes, she took steps toward obtaining adequate financial and technological resources (e.g., adequate stock of parts for performing maintenance and repair, improving the customer support request webpage, funding for employee training) to help employees achieve those outcomes and, subsequently, effectively meet the support needs of customers. In addition, these financial resources allowed Maria to invest in the performance of individual employees by improving hiring processes, enhancing training content and structure, and, most critically, improving the performance of team leaders within the division.
Job-Related Responsibilities (1,5)	Political Competency Securing Funding	State Funding Contribution	Effectiveness of Policy and Decision Making Consideration of Community Needs Performance Assessment and Monitoring	4. Lastly, Maria acknowledged that various contextual factors will influence how effectively she can implement her improvement plan (e.g., organizational culture, expectations of Maria's superiors). Though these factors may be outside of her control, she considered how they might influence the future of her division.
Contextual Influences (1,4)	Community Support	Number of Students Property Tax Values Socioeconomic Status	Socioeconomic Status State and Federal Mandates	5. Ultimately, by integrating all these factors, Maria was able to execute various actions and interventions that led to large improvement in the performance outcomes of the division.

Note. The superscripts for the example themes correspond to the numbered paragraphs in the case analogy.

Table 2

Rated Variables with Corresponding Definitions and Rating Cues

Variable	Definition	Rating Cues
Analogy		
Feature Mapping[a]	The number of shared features identified between the source domain (Maria) and the target domain (stakeholders)	Resources (funding, training, technology, etc.) Investment in personnel (school administrators, teachers, etc.) Performance outcomes (graduation rates, test scores, etc.) Contextual influences (community support, socioeconomic status, etc.)
Feature Elaboration	The level of detail in the analysis of the shared features and why they are important for understanding the stakeholders	Elaboration of specifics of shared features Identification and elaboration on themes Well thought out and detailed Meaningful integration and connection of information
Depth of Processing	The extent to which the response provides an in-depth analysis of the stakeholder information	Identification and elaboration on themes Meaningful integration and connection of information Discussion of many stakeholder concerns Discussion of multiple, if not all, stakeholders In-depth understanding of stakeholders' concerns
Forecasting		
Extensiveness	The extent to which the forecasts consider a wide range of actions, situations, reactions, and outcomes	Forecasting multiple actions, situations, reactions, and outcomes Forecasting with respect to multiple stakeholders Amount of forecasting
Timeframe	The extent to which the forecasted reactions and outcomes cover an extended timeframe	Forecasting long-term consequences of certain actions on stakeholders Forecasting stakeholders' reactions to long term actions and consequences
Mental Model Accuracy	The similarity between the illustrated stakeholder mental models and the true stakeholder mental models	Consideration of numerous stakeholder concepts and concerns Accurate depiction of the relationships between concepts
Plan		
Quality	The extent to which the plan is logical, complete, and useful	Well thought out and coherent Comprehensiveness in addressing critical elements of the task Realistic and appropriate
Originality	The extent to which the plan is novel, original, and unexpected	Novel, imaginative, unpredictable, innovative New, original, unique Not indicative of the "typical" plan
Elegance	The extent to which the parts of the plan flow well together in a refined clever, and well-crafted way	Plan flows smoothly and seamlessly Easy to follow, well-refined, and focused Clever and well-crafted
Stakeholder Consideration	The extent to which the plan considers stakeholders	Consideration of many stakeholder concerns Consideration of multiple, if not all, stakeholders Effective integration of concerns into plan

Note. [a] Feature mapping was simply a numerical total of shared features identified and was the only variable not rated from 1-5.

Table 3

Descriptive Statistics and Correlations

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Feature Mapping[a]	2.02	1.22	(.98)																
2. Feature Elaboration[a]	2.14	.91	.41**	(.90)															
3. Depth of Processing	2.79	.90	.08	.45**	(.87)														
4. Extensiveness[b]	2.52	.98	.14	.14	.41**	(.86)													
5. Timeframe[b]	2.57	1.06	.01	.14	.38**	.79**	(.84)												
6. MM Accuracy	2.07	.93	.22*	.20*	.21*	.19	.17	(.84)											
7. Quality	2.38	.90	.10	.12	.29**	.34**	.29**	.34**	(.83)										
8. Originality	2.34	1.05	.14	.01	-.07	.02	.03	.11	.26**	(.82)									
9. Elegance	2.23	.92	.04	.06	.14	.33**	.23*	.19**	.82**	.30**	(.82)								
10. SH Consideration	2.24	1.07	.05	.14	.24*	.28**	.26**	.33**	.62**	-.23**	.47**	(.83)							
11. DT—Fluency	5.39	1.43	.05	-.01	.02	-.04	-.09	-.07	.04	.03	.04	.04	(.80)						
12. Intelligence	25.9	5.85	.07	.06	.15	.04	.06	.21**	.13	-.06	.10	.12	.08	(.72)					
13. Spatial Reasoning	8.27	4.93	.24*	.15	.13	.11	.13	.15*	.00	-.01	.03	.11	-.01	.34**	(.85)				
14. Extraversion	5.85	1.21	.05	.01	.00	-.04	-.17	-.24**	-.10	.09	-.07	-.14	.12	-.14*	-.17*	(.90)			
15. Openness	6.51	.93	.09	.13	-.04	-.02	.03	-.03	.02	.08	.00	-.06	.06	.13	-.01	.21**	(.83)		
16. Expertise	2.47	.80	.09	.07	.12	.12	.12	.10	.16*	.20**	.16*	.00	.02	.10	.02	.03	.28**	(.75)	
17. Need for Cognition	3.14	.67	.06	.21*	.03	.20*	.17	.12	.17*	.18**	.17*	-.02	.03	.24**	.10	.05	.46**	.35**	(.89)

Note. $n = 211$. MM = Mental Model; SH = Stakeholder; DT = Divergent Thinking; Feature mapping was a total sum variable and the value along its diagonal indicates its ICC; Variables 2-10 were rated on a scale from 1-5 and the average r_{wg}'s for these are shown along the diagonal; Variables 11-17 show internal consistency coefficients (α) along the diagonal. [a] Analogical Reasoning manipulation scores. [b] Forecasting manipulation scores.
$^{*}p < .05$. $^{**}p < .01$.

Table 4

Univariate Analyses of Covariance for Creative Performance Criteria

	Quality				Originality				Elegance				Stakeholder Consideration			
Variable	*F*	*df*	*p*	η^2	*F*	*df*	*p*	η^2	*F*	*df*	*p*	η^2	*F*	*df*	*p*	η^2
Covariates																
Expertise					8.64	1, 194	$.00^{**}$	.04								
Main Effects																
Analogy	.24	1, 195	.62	.00	1.62	1, 194	.21	.01	.03	1, 195	.85	.00	4.38	1, 195	$.04^{*}$	.02
Depth of Processing	.04	1, 195	.85	.00	3.67	1, 194	.06	.02	.02	1, 195	.89	.00	.00	1, 195	.97	.00
Forecasting	3.40	1, 195	.07	.02	3.85	1, 194	.05	.02	.74	1, 195	.39	.00	10.58	1, 195	$.00^{**}$	.05
Mental Model Accuracy	17.80	1, 195	$.00^{**}$	.08	3.28	1, 194	.07	.02	5.01	1, 195	$.03^{*}$	.03	8.40	1, 195	$.00^{**}$	.04
Two-Way Interactions																
Analogy × Depth of Processing	.03	1, 195	.87	.00	.39	1, 194	.53	.00	3.42	1, 195	.07	.02	.01	1, 195	.93	.00
Analogy × Forecasting	.43	1, 195	.51	.00	.04	1, 194	.84	.00	.22	1, 195	.64	.00	1.57	1, 195	.21	.01
Analogy × MM Accuracy	4.00	1, 195	$.05^{*}$	.02	.09	1, 194	.76	.00	8.02	1, 195	$.01^{**}$	.04	1.63	1, 195	.20	.01
Depth of Processing × Forecasting	.76	1, 195	.38	.00	2.52	1, 194	.11	.01	1.72	1, 195	.19	.01	.86	1, 195	.35	.00
Depth of Processing × MM Accuracy	.88	1, 195	.35	.00	.96	1, 194	.33	.01	.38	1, 195	.54	.00	.61	1, 195	.44	.00
Forecasting × MM Accuracy	.63	1, 195	.43	.00	.05	1, 194	.82	.00	1.25	1, 195	.27	.01	.37	1, 195	.54	.00
Three-Way Interactions																
Analogy × Depth of Processing × Forecasting	.11	1, 195	.74	.00	.07	1, 194	.80	.00	.43	1, 195	.51	.00	.13	1, 195	.72	.00
Analogy × Depth of Processing × MM Accuracy	.97	1, 195	.33	.01	.16	1, 194	.69	.00	.94	1, 195	.33	.01	.54	1, 195	.46	.00
Analogy × Forecasting × MM Accuracy	.36	1, 195	.55	.00	.19	1, 194	.66	.00	.54	1, 195	.46	.00	.06	1, 195	.81	.00
Depth of Processing × Forecasting × MM Accuracy	.00	1, 195	.97	.00	.11	1, 194	.75	.00	.00	1, 195	.99	.00	.01	1, 195	.94	.00
Four-Way Interactions																
A × DP × F × MM	.15	1, 195	.70	.00	3.86	1, 194	.05	.02	.36	1, 195	.55	.00	1.07	1, 195	.30	.01

Note. $n = 211$. AR = Analogy; DP = Depth of Processing; F = Forecasting; MM = Mental Model; η^2 = effect size (partial eta squared).
$^{*}p < .05$. $^{**}p < .01$.

Table 5

Estimated Marginal Means for the Main Effects on Creative Performance

	Quality		Elegance		Stakeholder Consideration	
Condition	*M*	*SE*	*M*	*SE*	*M*	*SE*
Analogy						
Absent					2.109	.105
Present					2.414	.10
Forecasting						
Absent					2.498	.104
Present					2.025	.102
Mental Model Accuracy						
Low	2.132	.087	2.097	.091	2.051	.103
High	2.652	.087	2.384	.091	2.472	.103

Note. $n = 211$.

Table 6

Univariate Analysis of Covariance for Mental Model Accuracy

Variable	*F*	*df*	*p*	η^2
Covariates				
Extraversion	13.02	1, 202	$.00^{**}$	.06
Main Effects				
Analogy	.08	1, 202	.78	.00
Depth of Processing	4.25	1, 202	$.04^{*}$	.02
Forecasting	7.72	1, 202	$.01^{**}$	.04
Two-Way Interactions				
Analogy × Depth of Processing	.47	1, 202	.49	.00
Analogy × Forecasting	.47	1, 202	.50	.00
Depth of Processing × Forecasting	.94	1, 202	.33	.01
Three-Way Interactions				
Analogy × Depth of Processing × Forecasting	1.35	1, 202	.25	.01

Note. $n = 211$; η^2 = effect size (partial eta squared).
$^{*}p < .05$. $^{**}p < .01$.

Table 7

Estimated Marginal Means for the Main Effects on Mental Model Accuracy

	Mental Model Accuracy	
Condition	*M*	*SE*
Depth of Processing		
Absent	2.196	.087
Present	1.943	.086
Forecasting		
Absent	2.240	.087
Present	1.900	.086

Note. $n = 211$.

Figure 1

Excerpt from Module 2 of the Mental Model Illustration Training

Section 2. After thinking about this mode, Derek realizes there are other important issues he needs to address. He adds the following issues to the list:

1. **Size of the Sport Industry:** The amount buyers (consumers and businesses) are willing to spend on the sport.
2. **Salary/Contract:** The amount the team members and coaches are paid.
3. **Injuries:** The possibility that an athlete can get hurt in a game, during practice, or on their own time which would restrict them from playing.
4. **Public Promotion of Team:** The function of informing or influence people about the sport company's products, community involvement, or image.

He then adds these issues to his model to see changes in relationships between the issues.

Model #2

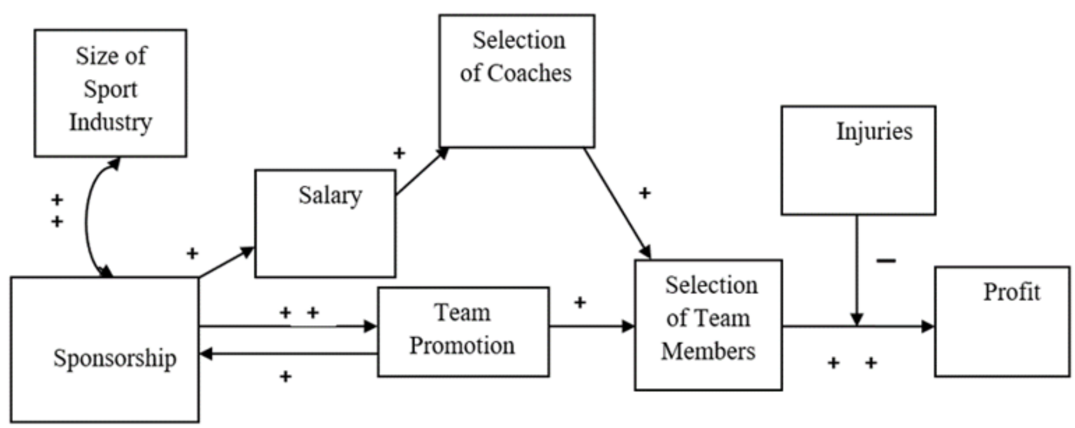


Figure 2

True Mental Models of Stakeholders

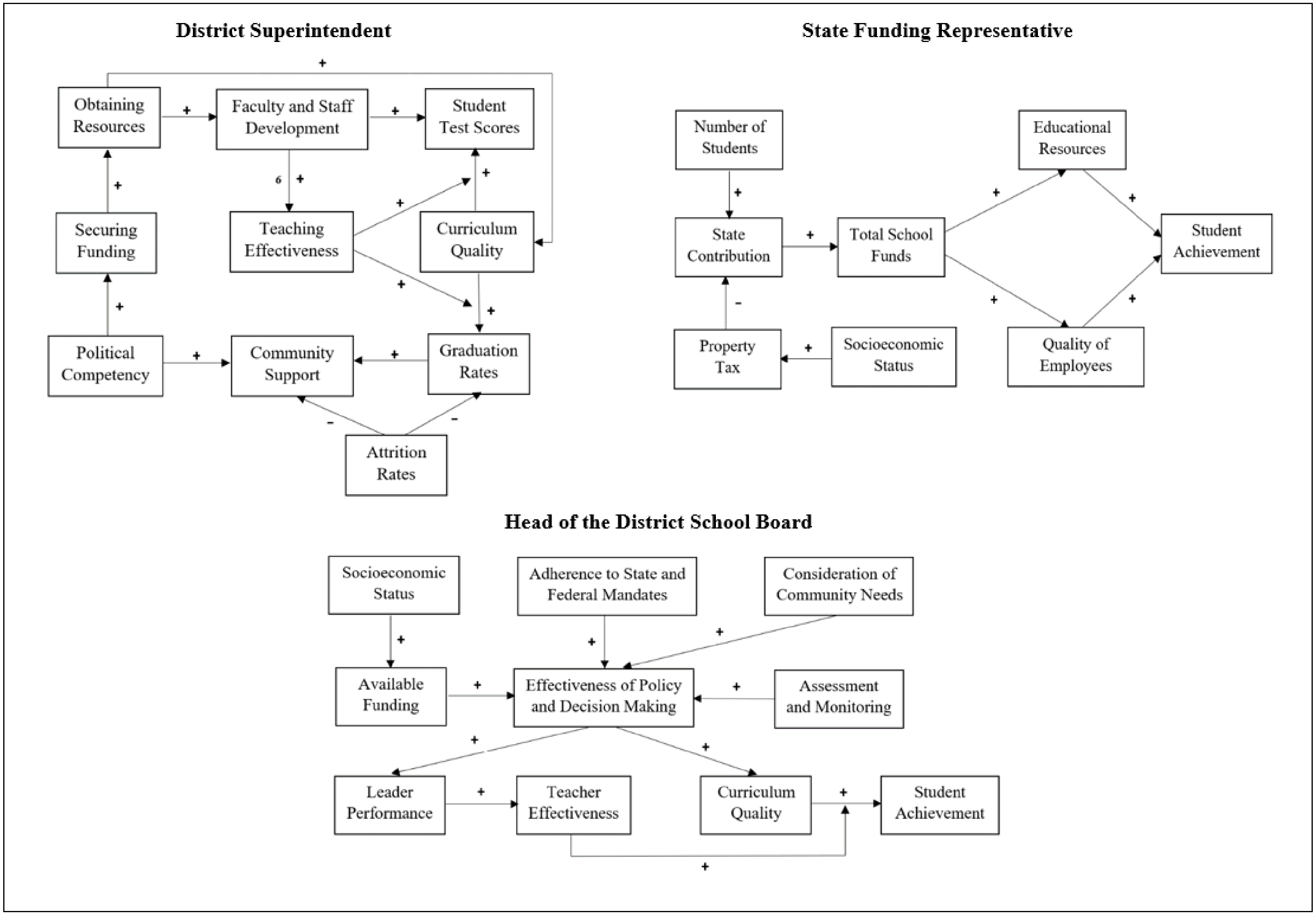


Figure 3

District Superintendent Case Information and Corresponding Mental Model

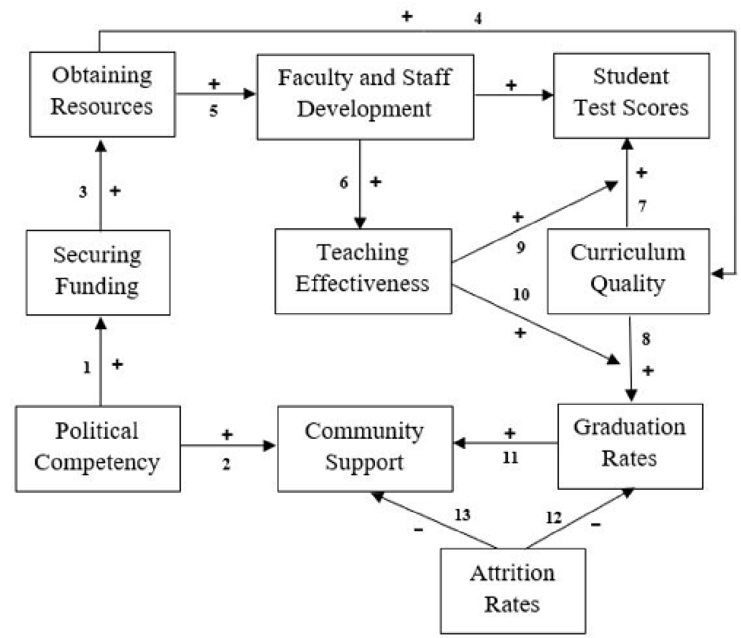
District Superintendent Case Information

As the district superintendent, I have many different responsibilities ranging from securing funding to ensuring curriculum quality, all of which contribute to student success. I have a specific responsibility to ensure that our schools have enough funding to be successful. Obtaining adequate funding is dependent on my ability to be politically competent[1]. As I demonstrate political competency, I am able to secure funding from a variety of sources. In addition, I also gain support from the community[2].

The more funding I secure, the more educational resources I am able to obtain[3]. Having more educational resources increases curriculum quality[4] (e.g., better textbooks, more access to technology, etc.). Also, resources give us the ability to create more faculty and staff development programs[5]. As opportunities to develop increase, teaching effectiveness increases as well[6]. As curriculum quality increases, student test scores[7] and graduation rates[8] also increase. However, it is important to note that although curriculum quality directly affects student tests scores and student graduation rates, these relationships are positively influenced by teaching effectiveness. In other words, when teachers are more effective, it improves the effect of the curriculum on student test scores[9] and student graduation rates[10].

As graduation rates increase, I receive more support from the community[11], however, when more students fail out or leave the school (i.e., a high attrition rate), graduation rates decrease[12] and community support also decreases[13].

District Superintendent Mental Model



Note. This figure demonstrates the mapping of relationships in the superintendent's mental model to the superintendent's case information. The superscripts within the case correspond to the numbered labels in the mental model. The procedure for ensuring this correspondence were the same for all three stakeholders.

Figure 4

Benchmark Rating Scale for Mental Model Accuracy

Mental Model Accuracy – State Funding Representative (Dave Smithers)

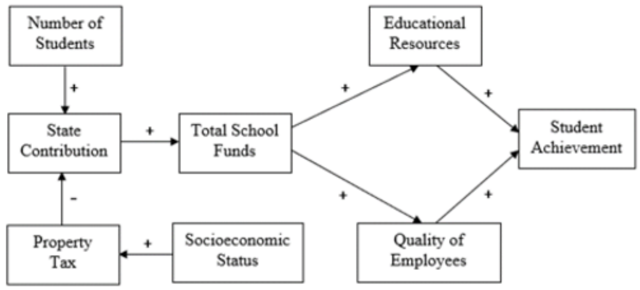
Definition: The similarity between the illustrated mental model and the true mental model

Things to consider:

Concepts: Number of accurate concepts depicted in the model

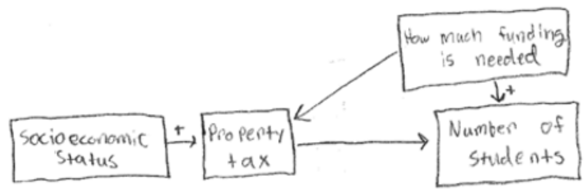
Relationships: Do they accurately depict the relationships between concepts? (e.g., positive, negative, mediating, moderating)

***State Funding Representative True Mental Model*:**

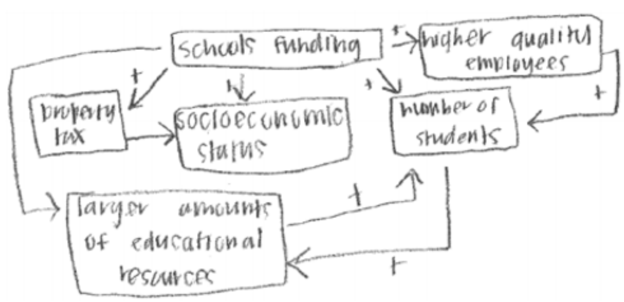


Head of District School Board Benchmarks:

1 – Low Accuracy: The mental model demonstrates low accuracy. The mental model will likely include a small number of concepts and/or concepts that are inaccurate or irrelevant. Additionally, the relationships depicted between concepts will likely be limited, inaccurate, or irrelevant.



3 – Moderate Accuracy: The mental model demonstrates moderate accuracy. The mental model will likely include some accurate concepts and relationships between concepts; however, there will likely be missing concepts and/or inaccurately represented relationships.



5 – High Accuracy: The mental model demonstrates high accuracy. The mental model will likely include most, if not all, of the relevant concepts. Additionally, the majority of the relationships depicted between concepts will generally be accurate.

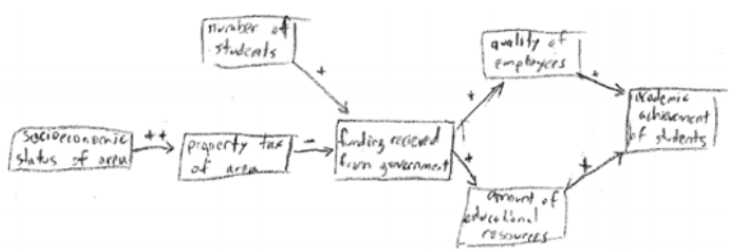


Figure 5

Benchmark Rating Scale for Quality

Plan - Quality

Definition: The extent to which the plan is logical, complete, and useful.

Things to look for:
Logical – Is the plan coherent? Is it well thought out?
Complete – Is the plan comprehensive? Does the participant address the critical elements of the task?
Useful – Is the plan a realistic and appropriate response for addressing the task?

Anchors:

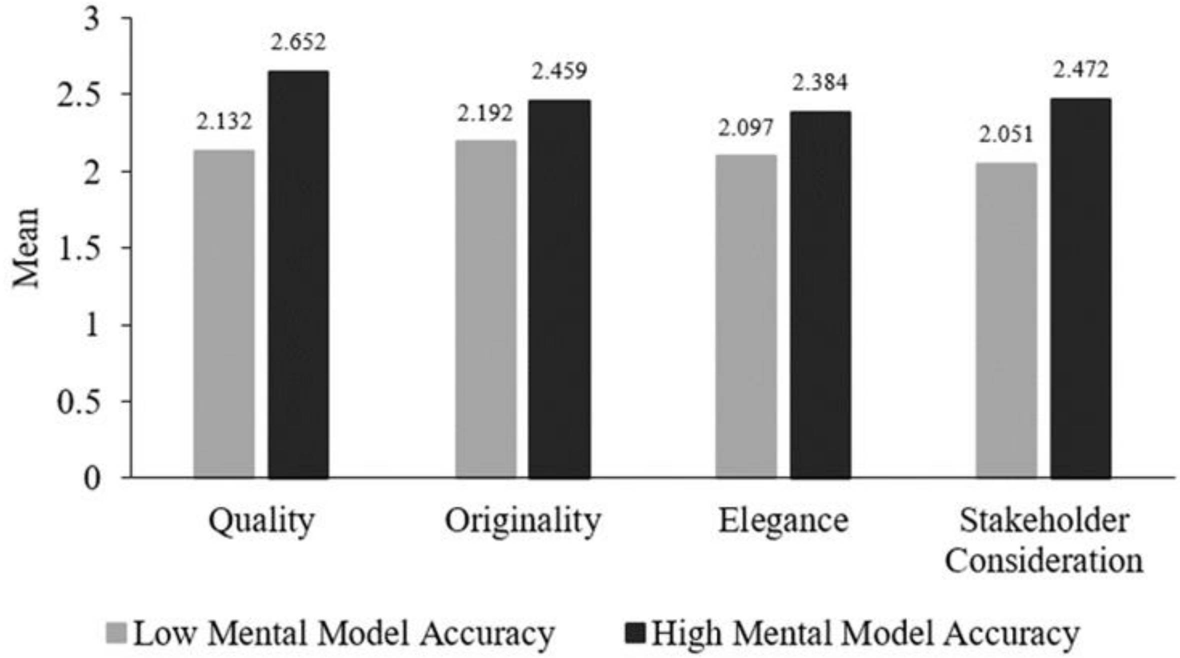
1 Low Quality	*Teaching strategies: let students work at their own pace, group/collaborative work, explain in multiple ways. Process improvement ideas: all grades will be separate, no major grades, can select classes you want to take. Special activities: prom, assembly for school spirit on Friday, free football game for students, sports, reward for doing well in school.*
3 Moderate Quality	*To begin I will need the help of the state funding representative and the district superintendent to ensure that the school district will have adequate amounts of funding. With adequate funds we can afford new training sessions for our teachers to learn new ways to make class more interesting for students so the students want to be there and want to learn. We will invest in new technologies for the science labs and computer labs so students can learn through hands-on experience. We will also have after school tutoring sessions that are free for students so if they are struggling and a subject they'll get the help they need and know that it is easy to get.*
5 High Quality	*Our students must be taught by the very best. Teachers must attend numerous workshops every summer and every nine weeks of the school year. They will learn multiple ways to present their information. That way they will be effective to all students in the class. Process improvement can be done by students and faculty. Evaluations can be made by students to mark what they don't understand or what can be improved by teachers. On top of this they can attend free academic development workshops during free periods of school where each student gets their own tutor/ mentor to help teach different learning tactics or break down info more thoroughly. Special activities will include, educational speakers coming to talk to the whole school, and research clubs. Community-technology experiments and historical field trips. Many more activities can be added throughout the school year after students fill out their surveys of which activities they'd like to see. This entire plan will need a large amount of funding so we'll need help. Educational plans and building plans can be put out for the community so they're aware of what's going on, this way we have a better chance of their support.*

Quick Guide

1	The plan is low quality. The plan is not comprehensive and does not address multiple key issues and concerns. The plan falls short in addressing issues in a logical, coherent, and useful manner.
3	The plan is average quality. The plan may address a few issues in a somewhat logical and useful manner, but a number of key issues may still be missing or vague, and it may fall somewhat short in its logic and usefulness.
5	The plan is high quality. The plan is comprehensive such that it addresses many key issues and concerns. The plan also addresses these issues in a manner that is very logical, useful, and coherent.

Figure 6

Effects of Low and High Mental Model Accuracy on Creative Performance



Note. Results for originality were non-significant.

Figure 7

Interaction of Mental Model Accuracy and the Analogy on Quality and Elegance