

The Development and Assessment of an Instrument for Measuring Mental Model Styles in Korea

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Abstract

This research study documents the development and validation of a new instrument for measuring individual mental model styles. In particular, the instrument is developed for use in organizational performance and change settings. Existing approaches to accessing and assessing mental models are reviewed, and the conclusion is drawn that none are survey-based, quantitative measures that are useful in organizational settings. Instrument development procedures with an expert panel as well as data collection and analysis are described. The resulting instrument is provided along with exploratory factor analysis and confirmatory factor analysis results. Recommendations for conducting further research and establishing continued validity are provided.

Keywords: Mental models, measurement, factor analysis

Mental Model Style: The Development and Assessment of a New Measure

Since the publication of Peter Senge's *The Fifth Discipline* in 1990, mental models have been a key feature of popular business language and have been increasingly studied by academic researchers (Argyris, 1985; Godet, 1987; Mason & Mitroff, 1981; Miller, 1986; Mintzberg, 1987a, 1987b, 1987c; Ohmae, 1988; Porter, 1985; Rosenberg & Schewe, 1985; Schwartz & Davis, 1981; Senge, 1990, 1994; Wack, 1985); yet most of this inquiry remains in the conceptual domain. Mental models have been most closely studied by cognitive psychologists in the context of language development (Johnson-Laird, 1983; Morecroft, 1983), but the concept of mental models now appears in almost every discipline. While the work done by psychologists may provide hints for understanding mental models in cognitive development, the existing literature does not necessarily apply in today's business organizations in which teams and team decisions, in increasingly complex situations, are the norm. This is primarily because of difficulties in measuring, assessing, and estimating mental models.

Many efforts at understanding and extracting mental models in an organizational context have been promising (Carley & Palmquist, 1992; Ward & Schreifer, 1998; Warren, 1995), but continue to fall short. Thus existing models are useful in helping consultants and change managers understand how people and groups are influenced by their past experiences (Allee, 1997), as well as how the ways in which they see the world affect their decisions and actions daily (Rochlin, 1998; 2009), is decidedly low. If we accept that mental models directly inform decision-making and action, then understanding how to change or influence mental models is another path to influencing decision-making and behavior. The problem, however, is that to understand the nature of mental models, how to access them, and how to change them has not been reached. The process is, however, known to be much more complex than simply taking out an old mental model and inserting a new one.

The practical utility of a measure of mental model styles is evident. For example, such an instrument could be used to track employee views of their organization throughout a variety of change management processes such as mergers and acquisitions, strategy development, and culture changes. Numerous other common workplace learning and performance interventions would benefit from snapshot assessments of mental models across the organization and work teams. Such information could be used to promote alignment if differences could be understood and resolved. Finally, an instrument measuring mental models could be used along with other instruments to fill in gaps or measure other dynamic aspects of the initiative. For example, work to create a learning culture might make use of the Dimensions of Learning Organization Questionnaire (DLOQ) developed by Watkins and Marsick (1992) to diagnose the learning culture. The proposed mental model styles instrument could be used to see where there are differences in mind-sets across the organization. Again, gaining leverage to help the development of a learning organization culture could be aided by understanding differing views inside the organization.

Problem Statement and Research Questions

The problem forming the basis of this research is not a new one, but one that has not yet been adequately addressed. This research attempts to solve the following twofold problem; first, currently available methods for accessing and assessing mental models of organizations have not been fruitful in understanding and influencing decision-making and behavior (Bechtel, 1998;

Doyle & Ford, 1999; Dudzinska-Przesmitzki & Grenier, 2009; Weick, 1990) and second, no measure of individual mental models of organizations currently exists. To summarize: *The problem is that there is no existing measure of mental models readily and efficiently useful in issues related to organization performance and change.*

Therefore the research questions serving as the basis of our inquiry were as follows:

- 1) What is an alternative or additional method for accessing and assessing mental models in organizations?
- 2) Can an instrument for accessing and assessing general mental model styles of organizations be developed?

Relevance for Learning and Performance Professionals

Specializing in learning and performance improvements (Swanson, 1999; 2001; McLean, 1998; 1999; Lee, 2004) in a variety of organizational contexts (McLean & McLean, 2000), Human Resource Development (HRD) professionals are well poised to make significant advances in the understanding and assessment of individual world-views, and how those views frame behavior. In other words, understanding mental models as a basis of behavior could provide an advantageous approach to lead change in organizations. In addition, the study of mental models falls within the domain of HRD in its variety of definitions. Individual mental models are not well understood and sound research in this area could bolster our understanding of more complex phenomena such as team dynamics and organizational culture (Korte & Chermack, 2007).

Few HRD scholars have inquired into the nature and assessment of mental models. In fact, few scholars from any discipline have studied mental models in detail. Relevant works from the HRD realm are in the form of literature reviews (Dudzinska-Przesmitzki & Grenier, 2009), reviews of existing tools (Rowe & Cook, 1995), thoughts on a research agenda (Johnson, 1995), or take mental models for granted as understood and link them to other phenomena (e.g., Johnson, 2008). While these inquiries have been useful in reviewing what is known about mental models, they have not generated new knowledge on the topic.

This article positions these prior inquiries as a unified springboard to create a survey instrument for measuring mental models. The article unfolds by defining and detailing mental models and linking them to metaphors of organizations. Once this connection is established, we describe the methods used to generate an initial survey for measuring these mental models and report specific statistical tests used to assess the validity and reliability of responses and research results. It should also be stressed that this article represents an initial effort at advancing the study of mental models by developing a survey instrument. We have stopped short of all that is required to make sure statements about an accurate and consistent instrument, and discuss our shortcomings clearly in our limitations section. Implications for HRD professionals are explored and conclusions are drawn.

Mental Models

Mental models include the biases, beliefs, experiences, and values of individuals (Ford & Sterman, 1998; Senge 1990) and are constantly interacting with patterns of perception, thought, and action. Further, as a result of action and learning, mental models evolve thus leading to a different way of understanding and acting in the world. Mental models constantly adjust, refine, and renew in dynamic and ever-changing environments. Mental models affect experience and are affected by experience. The general concept of mental models is widespread in the literature even though agreement on precise definitions and constructs is lacking. At the conceptual level,

most researchers agree that mental models are cognitive structures representing knowledge and beliefs (Bechtel, 1998; Doyle & Ford, 1999; Weick, 1990). Mental models are simplified structures that help individuals acquire, process, and respond to information more efficiently. These models explain how information and knowledge are structured in the mind (Klimoski & Mohammed, 1994). Rouse and Morris (1986) described the functionality of mental models as a framework for describing, explaining, and predicting future conditions of systems.

Allee (1997) stated that mental models are “important cornerstones for building knowledge and defining some of the cognitive processes that support change and learning” (p. 11). Originally introduced by Forrester (1961), mental models are the lenses through which we see the world. Senge (1990) defined mental models as “deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action. Very often, we are not consciously aware of our mental models or the effects they have on our behavior” (p. 8).

Doyle and Ford (1999) explored the concept of mental models in detail: “Mental models are thus the stock in trade of research and practice in system dynamics: they are the ‘product’ that modelers take from students and clients, disassemble, and reconfigure, add to, subtract from, and return with value added” (p. 4). After providing a comprehensive literature review of the terms from both the systems dynamics and cognitive psychological perspectives, and initiating discussion in *Systems Dynamics Review*, Doyle and Ford (1999) offered the following revised definition of mental models: “A mental model of a dynamic system is a relatively enduring and accessible, but limited, internal conceptual representation of an external system (historical, existing or projected) whose structure is analogous to the perceived structure of that system” (p. 414). Further, Weick (1979; 1985; 1990) has argued consistently that mental models guide, shape, and provide the basis for individuals to interpret and make sense of organizational life.

Researchers have generally studied mental models as factors in strategic decision-making and the performance of individuals, groups, and teams (Klimoski & Mohammed, 1994). Both differences and similarities exist between these two streams of research. For the purposes of changing organizational culture, both directions are important and scenario planning could affect the decisions defining future directions of the organization and the implementation of new direction throughout the organization. A change in direction fosters a change in culture.

Representations

Cognitive psychology literature has focused on mental representations. Representations refer to the way humans build “stand-ins” for reality in their minds. “One of the functions of representations is to stand in for things outside the system; once a system has representations, it can operate on them and not need the world” (Bechtel, 1998, p. 297). The concept of representation can best be introduced by considering that the mind and brain are involved in “coordinating the behavior of an organism in its environment” (Bechtel, 1998, p. 297). In order to coordinate such behavior, an organism must create some working understanding of its environment and it does so by constructing a mental representation or model of that environment (Johnson-Laird, 1983).

Freyd (1987) suggested that mental representations are also dynamic. That is “perceivers are sensitive to implicit dynamic information even when they are not able to observe real-time changes” (Freyd, 1987, p. 427). The significance of Freyd’s (1987) research is its suggestion that the human mind is itself anticipatory in its perception and construction of events. That is, the human mind naturally anticipates possible future sequences of actions based on immediate

perceptions.

To be sure, mental models (and related concepts) have a variety of names. Worldviews, mind-sets, mental models, and representations are all referring to related concepts. While the mental model label is popular in business and industry literature, a classification of the nuanced differences among these titles, and a conceptual review of each would add greatly to the literature.

A Review of Approaches to Mental Models

Dudzinska-Przesmitzki and Grenier (2009) provided a review of different approaches to eliciting mental models and concluded that the vast majority of mental model literature is left in the conceptual domain, and little practical utility is offered. This conclusion lent further support to the utility of this research study and our core purpose of attempting to develop an instrument to measure mental model styles in organizational contexts. Their key contribution was a presentation of three types of mental model elicitation methods: (1) verbal, (2) graphical, and (3) hybrid. In summary, the review provided by Dudzinska-Przesmitzki and Grenier (2009) confirmed our problem statement and provided support for our quest to move beyond interviews and mind-maps in measuring mental models.

Mental Models of Organizations

All of the methods for eliciting mental models discussed by Dudzinska-Przesmitzki and Grenier (2009) are targeted at mental models in general, and none are intended for use specifically with regard to individual mental models of organizations. Organizational researchers are frequently interested in how individuals view the organization -- their mental model of the organization. While the methods discussed by Dudzinska-Przesmitzki and Grenier (2009) are useful in extracting a variety of nuances and detail, our approach aimed for a faster, albeit much more crude method of eliciting mental models by attempting to develop a survey instrument. A key goal of this research study, therefore, was to develop a survey instrument that would provide a snapshot of participants' current view, or mental model of the organization. With certainty, the limitations to accessing and assessing mental models from a quantitative position are discussed in detail.

Theoretical Framework

The purposes of this research were to explore the possibility of a survey approach to eliciting mental models, and if early stages were successful, develop an instrument measuring mental model style. A key assumption was that generic mental model categories (we called mental model styles) existed and could be confirmed. By far, the most useful existing work that informed a theoretical framework for this study was Morgan's (1998) *Images of Organization*. Each of Morgan's images is essentially a worldview, representation, set of assumptions, or mental model of organizations. Morgan reviewed eight common images (or mental models) of organizations, namely, organizations as (1) machines, (2) organisms, (3) brains, (4) cultures, (5) political systems, (6) psychic prisons, (7) flux and transformation, and (8) instruments of domination. Each of these mental models of organization is described briefly to present the over-arching theoretical framework for this study.

Organizations as Machines

Viewing organizations as machines is a product of the industrial revolution and Frederick Taylor's approach to scientific management. In this view, efficiency is the goal and value chains dominate operations—the organization should operate like a well-oiled machine, and process

models like the assembly line. This mental model is based on assumptions of a capitalist economy, maximization of profit as the main organizational goal, rational behavior, a consistently hard work ethic, and increased market size as desirable in order to achieve economies of scale.

Organizations as Organisms

Drawing from early systems theory, this mental model style of organizations is based on observations of natural and biological systems. This mental model style extends characteristics of biological systems to organizations in hopes that lessons learned in the natural world apply in the organizational world. Focusing mainly on the concept of natural selection, this mental model style features the ability of organizations to “fit” with their external environments. Organizations that find niche markets and consistently outperform the competition will survive. This mental model style also emphasizes resource allocation and the ability to react quickly to changes in the environment.

Organizations as Brains

An entire sub-discipline of management has focused on organization cognition. Network theory, distributed cognition, organizational learning, and intelligence are all characteristics featured in the mental model style of the organization as a brain. The goal of organizations in this view is to become flexible, resilient, and innovative in order to evolve. These organizations can learn to do new things in new ways. Argyris’ double-loop learning (1985), or the ability to learn how to learn, is a key goal of this view in understanding and explaining how organizations behave like human brains.

Organizations as Cultures

Organizations viewed from this mental model style are their own mini-societies with unique values, artifacts, and beliefs. Shared meanings are the vehicle for change and renewal in organizations as cultures. Uniforms, trademark behaviors, unique styles, and other catchy but competitive edges are often used on organizations and can be indicators of this mental model. In this view, organizations must have elaborate enculturation processes to help people adopt and adapt to the new system of behaviors and beliefs.

Organizations as Political Systems

Organizations can clearly be forums for negotiating personal agendas. This mental model style compares management structures to government structures, often with a variety of interests, stakeholders, and constituents coming into play. Decision-making and other organizational processes can be bureaucratic, technocratic, or democratic, each underscoring a different ideological undercurrent. Conflict management and power distribution management skills are particularly useful in organizations operating under this mental model style.

Organizations as Psychic Prisons

Groupthink and other patterns of thinking and doing that wind up simply passing the time are characteristic of this mental model. Having the same meetings, pushing the same initiatives, and working toward the same goals over and over again are examples of behaviors that represent the view of organizations as a fabricated sense of security and order in a chaotic world.

Organizations as Flux and Transformation

This mental model style views organizations as constantly changing entities. Stability, or a state of rest is a myth, and therefore attempts at measuring characteristics of organizations are merely snapshots. Such snapshots are nothing more than a moment of data, and useful measurement attempts look at organizations over time. Chaos, complexity, and dialectical theories are useful in exploring the possible avenues of organizational evolution according to this mental model style.

Organizations as Instruments of Domination

Viewing organizations as instruments of domination is based on the Marxist idea that organizations exploit the efforts of numerous individuals for the gain of a few. Social and personal stress, workaholicism, and the increasing global power of many large organizations serve as evidence that social hierarchies and classes are in order. This mental model style suggests that workers are often oppressed by the financial and political agendas of senior executives and shareholders.

The Importance of Mental Models in Organizations

Mental models are an important part of organizational life, and therefore, organizational research. The literature reviewed thus far suggests that mental models are not well understood. Much of what exists in the mental model literature is speculative and tends to expand the ways in which we might try to understand how values are formed. Because mental models house the beliefs, values, experiences, and preferences of individuals, understanding them can be a potential window into explaining behavior. This understanding would be of high utility to human resource development, management, and organization science practitioners as well as researchers. Almost sixty years after Lewin's (1957) breakthrough with group processes, there is still much to learn about why people make the decisions they do.

This research takes a different approach to accessing and assessing individual mental models of organizations in hopes that the resulting instrument can be useful in understanding an aspect of individual perspective and therefore behavior in organizations.

Methods

This study was conducted in two parts, namely (a) the development of the scale and (b) the testing of the scale with statistical procedures. Methods for both parts are described in detail. It should be noted that this study is only the start of establishing the necessary criterion, content, and nomological validity for such an instrument to be useful, and our research did not assess the nomological validity of the proposed instrument.

Methods Part One -- Generating the Scale

A keyword search for "mental models" using the electronic library of a major Western university yielded 823 results, which were then screened for relevance. Sources not relevant to organization, management, and decision-making were screened out, thus leaving 461 sources. Continued review of these sources and screening by two of the authors for relevance in measuring mental models yielded a final group of 23 sources related to the purpose of this research. Given that efforts to measure mental models have generally been limited, and specifically, that none attempted a quantitative / survey approach to measuring mental models, it

is not surprising that only 23 sources were judged to be particularly informative in this research.

From the relevant literature, ten preliminary categories of mental model styles were identified through a literature review. Morgan's (1998) *Images of Organization* provided eight common ways of seeing organizations, which are a natural equation to individual mental models of organizations given that they include the assumptions and experiences "that lead us to understand situations in powerful yet *partial* ways" (Morgan, 1998, p. 4, italics in original). Morgan's work suited the task as it proposed a clear scheme for classifying how individuals view organizations, and additional sources were sought. In addition, most of the 23 sources judged useful for informing mental model styles had content overlapping with one of Morgan's eight categories. Swanson's (2007) views of organizations were also considered, along with works by Van de Ven and Poole (1995), and Watkins and Marsick (1996; 1997; 2003). These additional sources were considered to extend the research and include scholars in the learning and performance disciplines as their individual research agendas have contributed much to the literature on how people view organizations and their roles within. Ten final general categories of mental model style were identified. Obvious omissions by Morgan that appear as independent and frequent themes in HRD literature include systems theory (or a systems view) and social networking or social interaction.

Experts

Nine subject matter experts were identified through a screening process based on activity related to mental models in the organizational learning, human resource development, management, and other related disciplines. These nine experts were invited to participate as subject matter experts in developing an instrument for measuring mental models of organizations. Four of the nine individuals accepted and were interested in sharing their thoughts on each of the categories, suggesting the addition or removal of categories, and writing items for each category.

The four subject matter experts were asked to review an initial document containing a single question (what do you think are the common ways individuals view organizations?), followed by a simple listing of the ten general categories identified in the literature. Experts were asked to add to, modify, and / or change the list. A final list was compiled and sent back to the experts. Experts were asked to write three questions (or items) that could be used as survey questions for each mental model. At this point one expert dropped out of the project. Three experts wrote suggested items. The items were compiled into a draft survey. The draft survey was sent back to the experts for a final round of review. Again, experts were asked to add to, modify, and / or change the survey based on their expertise. A final survey was developed based on changes and recommendations from three expert reviewers.

The resulting survey was titled the Mental Model Style Survey (MMSS), contained 25 items placed on five-point Likert scales, and was intended to measure participant mental model styles of organizations. The expert review process established the face validity of the instrument, and the next phase of research was to gather data for evaluating the statistical validity of survey scores.

Methods Part Two -- Analysis of Responses with Statistical Techniques

The following sections describe the sample, instrument, and analysis techniques used in this research study.

Sample

The target population for this study was managers in general, and the recommendation of including ten participants for each variable or item was used as a minimum criterion (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Yang, 2005). Given the structure of the instrument, a sample size of 250 would be adequate.

The sample for this study included 709 individuals from several different industries, which included manufacturing, electronics, constructions, and finance organizations in Korea. Participants were selected based on convenience, ease of access, and willingness to participate in this research. The survey was posted online and participants from selected companies were invited to fill it out. The total number of invited participants was approximately 1,500, of which 709 replied thus yielding a response rate of 47%. In terms of the sample specification, 309 cases were collected from companies with less than 100 employees, and 400 cases were collected from medium and large organizations with more than 100 employees. Among the 709 participants, approximately 54% were male and 7% did not respond to the gender identification question. About 34% of participants were involved in human resource development and management, 28% in production and marketing, 24% in IT service and technology support, and 12% in research and development. Regarding work position, 8% were senior-level managers (e.g., directors and executives), 32% were general managers, and the rest of the respondents were associate managers (23%) and entry-level full-time employees (29%). Follow-up with non-respondents was not attempted for this study.

Instrument

The instrument used in this study was the Mental Model Style Survey (MMSS), developed with experts as described. The MMSS is intended to assess participant mental models of their organizations. The instrument contained five factors, (Political Mental Model Style, Financial Mental Model Style, Efficiency Mental Model Style, Social Interaction Mental Model Style, and Systems Mental Model Style), each with 5 items, for a total of 25 items. Each item is ranked on a five-point Likert scale (1=Never, 2=Sometimes, 3= Often, 4=Usually, and 5=Always). This study focused on assessing the reliability and validity of scores generated by the MMSS in order to determine its ability to measure the intended characteristics.

Translation

Given the opportunity to gather data from large organizations in Korea, we adopted the traditional forward and backward translation procedure to secure linguistic equivalence between the English and Korean versions of the MMSS (Hui & Triandis, 1985). Linguistic equivalence refers to the degree of matching each scale item between the English and Korean versions of the MMSS in terms of the meaning, nuance, and connotation (Brislin, 1970; Cha, Kim & Erlen, 2007; McGorry, 2000). A total of five experts – two bilingual human resource development major professors, one bilingual organization development major doctoral candidate, two linguistic major doctoral candidates -- were involved in the forward-then-back translation procedure. The forward translation process was performed independently and combined together to finalize the initial Korean version of MMSS. The backward translation was performed independently along with a final evaluation by linguistic experts confirming the equivalence of the two versions. All comments and minor changes were incorporated to finalize the Korean version of MMSS.

Analysis Plan

Aligned with the primary purpose of this research, the following statistical procedures were performed: (1) exploratory factor analysis (EFA) of the theoretically proposed scales, (2) confirmatory factor analysis (CFA) of the revised factor structure resulting from the EFA, and (3) reliability analysis of the final scale scores. All data analyses were performed with SPSS and LISREL statistical software. A total of 701 completed responses were used for further data analysis after deleting non-completed responses.

Because we were able to obtain an adequate sample size ($n = 701$), according to the Central Limit Theorem (CLT), basic normal distribution could be assumed (Rice, 2006; Urdan, 2005). Empirically, the pattern and shape of the sample distribution supported normal distribution as well in terms of the Skewness values (ranges from $-.470$ to $-.179$) and Kurtosis values (ranges from $-.467$ to $.515$) (Hair, Black, Babin, Anderson, & Tatham, 2006; Leech, Barrett & Morgan, 2005).

Construct Reliability and Validity

EFAs were conducted using responses from a randomly chosen half of the sample ($n_1 = 348$) to examine the factor structure of the MMSS against its theoretical model. The remaining responses were saved for a CFA ($n_2 = 353$) to confirm the results of the EFA. The full sample was then used to compute reliability coefficients for the final scale scores.

EFA was chosen as the first analysis strategy based on our expectation that the theoretical model of the MMSS might not fit the data well and that the factor model would require refinement. Our goal was to isolate factors that had a simple structure or as Thompson (2004) indicated, were interpretable. For the EFAs, we used principal axis factoring and promax rotation. These methods were chosen because an underlying theoretical structure was hypothesized and it was expected that some of the factors would correlate (c.f., Henson & Roberts, 2006).

To confirm the psychometric properties of the MMSS scales derived from the EFA, a CFA was conducted. CFA is regarded as one of the most reliable tests to assess the construct validity of the proposed measurement based on fitness between measurement and collected responses (Hair et al., 2006; Thompson, 2004). To assess model fit, two error term detection indices, Steiger's root mean square error of approximation (RMSEA; 1990) and Jöreskog and Sörbom's standardized root mean square residual (SRMR; 2001), and four goodness of model fit indices, Jöreskog & Sörbom's goodness-of-fit index (GFI; 2001), Bentler's comparative fit index (CFI; 1990), Bentler and Bonett's nonnormed fit index (NNFI; 1980), and goodness-of-fit (GFI) were considered along with basic chi-square estimates.

To assess reliability of MMSS scale scores, coefficient alpha was used. Coefficient alpha is a common statistic used to measure the internal consistency of scale scores (Henson, 2001).

Results

This section presents the results of the EFA, CFA, and reliability analyses for the subsample 1, subsample 2, and the full sample, respectively, along with descriptive statistics.

EFA (Subsample 1)

In the initial EFA, five factors were extracted in keeping with the theoretical model of the items. The five factors explained 62.87% of the variance of the 25 items. An analysis of the

pattern and structure matrices indicated that two of the items did not load on their respective factor and eight items cross-loaded with another factor. A cursory review of these items showed that their wording was imprecise, leading to cross-loading.

A total of 15 items were subjected to a second EFA, where five factors were again extracted, accounting for 57.44% of the variance of the 15 items. Table 1 presents means, standard deviations, and path and structure coefficients for the final set of items. All items had pattern coefficients in excess of .40 on their respective factor with no cross-loadings on other factors. Analysis of structure coefficients indicated that all items correlated most highly with their theoretical factor. Interfactor correlations ranged from .36 to .71, suggesting a higher order structure.

Table 1

Mean, Standard Deviation, Standardized Path (P) and Structure (S) Coefficients for Subsample 1

Item	M	SD	Political MMS		Financial MMS		Efficiency MMS		Social Interaction MMS		System MMS	
			P	S	P	S	P	S	P	S	P	S
1	3.68	.84	.66	.66	-.07	.25	-.01	.41	.03	.37	.04	.41
2	3.75	.80	.88	.84	.03	.39	-.05	.47	-.01	.39	-.04	.43
3	3.51	.75	.41	.56	.11	.37	.19	.47	-.08	.32	.04	.37
6	3.43	.82	-.02	.34	.69	.69	-.03	.38	-.09	.26	.17	.29
7	3.35	.85	.10	.37	.70	.71	-.10	.34	.10	.30	-.07	.20
10	3.26	.88	-.08	.24	.56	.59	.20	.36	.02	.22	-.12	.14
11	3.74	.76	.08	.52	.07	.45	.70	.76	.07	.51	-.09	.48
12	3.91	.79	.00	.50	-.01	.41	.84	.82	-.03	.51	.01	.54
13	3.86	.73	-.06	.48	.01	.42	.87	.84	-.02	.52	.02	.55
17	3.79	.74	.13	.47	-.11	.24	.14	.55	.59	.71	.01	.56
19	3.80	.79	-.04	.38	.02	.29	-.05	.48	.95	.84	-.09	.53
20	3.62	.76	-.07	.35	.09	.30	-.05	.45	.66	.71	.12	.54
22	3.83	.74	.11	.53	-.06	.28	.20	.62	.18	.63	.41	.71
24	3.81	.81	.00	.50	-.01	.24	-.07	.56	.02	.64	.94	.90
25	3.89	.81	-.03	.47	.04	.32	.13	.61	.23	.67	.50	.75

Note. Salient pattern coefficients (greater than .4) are bolded. MMS = Mental Model Style.

CFA (Subsample 2)

The CFA model used was a hierarchical model in which the 15 MMSS items from the final EFA were arranged in five factors, each of which was related to a second-order *mental model style* factor (see Figure 1). Correlations between the first-order and the second-order *mental model style* ranged from .45 - .94. The first-order factor, *efficiency mental model style* had the lowest correlation with the second-order factor while the first-order factors *financial mental model style* and *system mental model style* had the highest. Results of commonly used goodness-of-fit indices indicated that the model fit the data reasonably well. Comparative fit index (CFI = .96), goodness of fit index (GFI = .94), and Tucker-Lewis Index (TLI = .95) all met or came close to meeting the oft-recommended criterion value of .95 (c.f., Schumacker & Lomax, 1996). Root mean square error of approximation (RMSEA = .053; 90% CI: .041-.065) was close to the recommended level of .06 (Hu & Bentler, 1999). Standardized root mean square residual (SRMR = .031) indicated a low chance of measurement error based on the common rule of standardized

residual level of .1 (Hair, Black, Babin, & Anderson, 2010). The hierarchical model fit the data better than a single factor model where all 21 items were directly loaded on *mental model style* ($\Delta\chi^2[5] = 261.18, p < .001$).

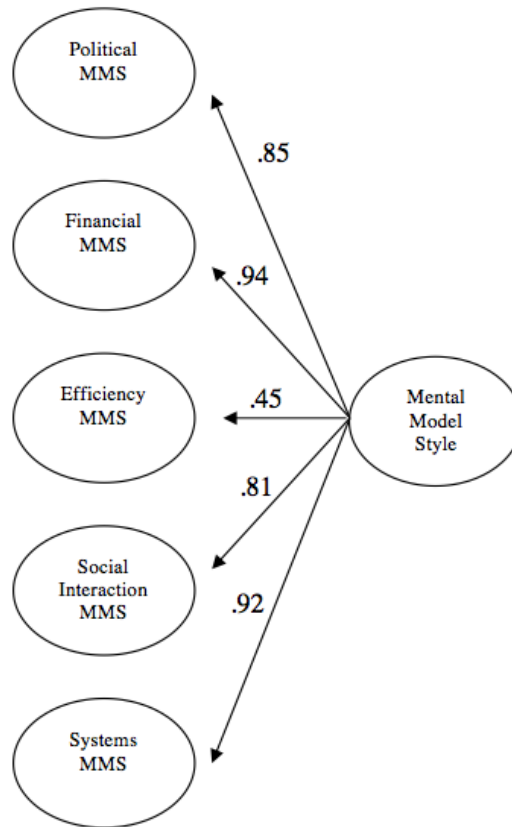


Figure 1. Mental Model Style Survey Factor Model. MMS = Mental Model Style.

Table 2 presents the means, standard deviations, and the first-order pattern and structure coefficients for the 15 MMSS items subjected to the hierarchical CFA. First-order pattern coefficient values were all above .60, except one item (.52) under the first-order factor, financial mental model style, indicating fairly appropriate measurement structure in terms of the pairs between developed measurement items and assigned first-order latent constructs (c.f. Bagozzi & Yi, 1988; Kline, 2005; Hair et al., 2010). Analysis of structure coefficients (Graham, Guthrie, & Thompson, 2003) indicated that all of the items correlated most highly with their theoretical first-order factor. According to the CFA results, it is reasonable to state that the Korean version of mental model measurement holds and functions appropriately in the Korean cultural context.

Table 2

Mean, Standard Deviation, Standardized Path (P) and Structure (S) Coefficients for Subsample 2

Item	<i>M</i>	<i>SD</i>	P	S	P	S	P	S	P	S	P	S
1	3.79	.87	.64	.64	.00	.23	.00	.44	.00	.49	.00	.48
2	3.79	.76	.79	.79	.00	.29	.00	.55	.00	.60	.00	.59
3	3.56	.73	.63	.63	.00	.23	.00	.44	.00	.48	.00	.47
6	3.40	.83	.00	.24	.65	.65	.00	.25	.00	.27	.00	.27
7	3.29	.88	.00	.23	.63	.63	.00	.24	.00	.26	.00	.26
10	3.26	.88	.00	.19	.52	.52	.00	.20	.00	.22	.00	.21
11	3.90	.79	.00	.58	.00	.32	.83	.83	.00	.66	.00	.65
12	3.93	.81	.00	.59	.00	.33	.85	.85	.00	.68	.00	.67
13	3.88	.76	.00	.55	.00	.30	.79	.79	.00	.63	.00	.62
17	3.81	.76	.00	.56	.00	.31	.00	.59	.73	.73	.00	.63
19	3.80	.87	.00	.58	.00	.32	.00	.61	.77	.77	.00	.66
20	3.64	.80	.00	.49	.00	.27	.00	.51	.64	.64	.00	.55
22	3.93	.79	.00	.57	.00	.32	.00	.60	.00	.66	.76	.76
24	3.81	.80	.00	.55	.00	.30	.00	.58	.00	.63	.74	.74
25	3.88	.82	.00	.57	.00	.32	.00	.60	.00	.66	.76	.76

Reliability (Full sample)

Coefficient alpha for scores from each subscale and the overall scale are included in Table 3. The reliability coefficients ranged from .66 to .89. Given that these values fell above or were close to the standard cutoff of .70 (Streiner, 1993) or alternatively, .80 (Henson, 2001), the items on each subscale/scale of the MMSS appear to be highly related. The alpha value of each MMSS scale without each item was examined to determine if any of the items detracted from the scales' overall homogeneity. There was no instance in which the removal of a specific item increased homogeneity.

Table 3

Means, Standard Deviations, Reliability Estimates, and Correlations for Scale Scores for Full Sample (n=701)

Scale	<i>M</i>	<i>SD</i>	1	2	3	4	5	5
1. Political MMS	11.04	1.90	.72					
2. Financial MMS	9.99	1.99	.35	.66				
3. Efficiency MMS	11.55	2.04	.55	.41	.86			
4. Social Interaction MMS	11.23	1.96	.47	.29	.59	.77		
5. Systems MMS	11.58	2.04	.55	.24	.63	.68	.82	
6. Mental Model Style	55.39	7.57	.76	.60	.84	.80	.82	.89

Note. Reliability estimates are along the diagonal.

Research Limitations

This section describes the limitations to this research and draws conclusions based on the results of data analysis. This research has three major limitations, namely, (1) a lack of nomological validity, (2) use of a single cultural sample, and (3) the social desirability of responses. These limitations are described and discussed.

Lack of Nomological Validity

The study used factor analysis methods to establish the internal validity of the instrument scores, but did not relate these scores to other, perhaps more established measures of similar constructs. A study that established nomological validity would situate the Mental Model Style Survey in a system of other similar constructs and create a nomological net. The nomological net would further confirm or disconfirm the validity of MMSS scores as the nomological net would confirm that the survey scores behaved as theorized within that system of similar constructs (Cronbach & Meehl, 1955).

Use of a Single Cultural Sample

This study was conducted entirely in Korea. While the instrument was developed in English, the opportunity for a validation study with Korean companies formed the basis of this study. The results suggest a reduced-item instrument that has provided valid and reliable scores after translation to Korean, and using Korean participants. Clearly needed are additional validation studies using samples from the culture in which the instrument is intended to be used. In addition, validation is an ongoing process, and additional validation studies are needed to continue establishing the utility of the MMSS.

The Social Desirability of Responses

Instruments using self-reported data are susceptible to faking, or participants providing the responses they think researchers would like to receive. Several techniques and designs can be used to determine a measure's susceptibility to faking (Loo, 2000), and future research using the MMSS could consider examining this tendency. Additional high-utility studies would link the MMSS to another objective behavioral measure.

Implications for Human Resource Development

This research is not intended to dismiss the complexity of mental models. Rather, it is designed to create a way to efficiently measure individual tendencies to view organizations in certain ways. The proposed instrument could be a useful consulting and research tool to assess the general view of the organization, from the various stakeholder perspectives and therefore could be used to manage organizational change. Further, with considerable additional effort toward establishing a consistent and accurate measure of individual mental models of organizations, researchers could significantly advance the body of knowledge around mental models. Our study proposes that HRD professionals are in a position to lead the effort to understand mental models in a variety of ways and answer Johnson's (1998) suggestions for moving knowledge forward in this area. With vast expertise in the scholarship of performance and learning (Swanson, 1994; 2007; Watkins, 1993), HRD scholars have a strong foundation on which to build a more precise set of tools for dissecting and understating the mental models that influence behavior in organizations.

The instrument resulting from this research is decidedly simple and could certainly use expansion. Without question, there are other mental models that individuals might hold of their organizations, and further study should increase the variety of perspectives measured in such a survey.

Conclusions

The results of this study indicate that an initial instrument measuring mental model styles can be developed from the literature and subject matter experts. Experts established the content validity of the initial instrument and data supported its utility and validity. The final survey

instrument produced alpha coefficient scores of .72, .66, .86, .77, and .82, all of which are close to Nunnally's recommended .70 (1970). This research study confirms that a survey approach to measuring mental models is possible and can produce valid and reliable scores. The resulting instrument has high potential utility in organizational research because it is an efficient snapshot of internal mental models of organizations, but more use and further research are needed.

EFA identified items that could be deleted from the survey instrument and CFA generally confirmed the factor structure, allowing the conclusion that the resulting 15-item MMSS indeed measures participant perceptions of mental model style and does so with relative accuracy and consistency in the Korean cultural context. However, an effort to replace deleted items and increase the robustness of the instrument can be considered a direction for future research. In summary, data indicate a good start on an instrument for measuring mental model styles, but more work is required.

Implications for Practice

Our research suggests that a valid and reliable measure of mental model styles can be developed. While instrument development is an ongoing process, our research is promising. Additional studies will further establish instrument validity and reliability in a variety of contexts. The practical implications of the research we have presented are that a snapshot diagnosis of mental model styles within the organization is possible, and could be used in various consulting engagements in a variety of ways. Mergers and acquisitions, strategy development, scenario planning, culture change, and team development are all relevant interventions in which it would be useful to know the varying mental model styles, and how they might be changed.

Implications for Research

Clearly additional studies must be conducted to establish the validity and reliability of scores in varying contexts in order for the proposed instrument to be useful. Initial estimates indicate a good start on this instrument and larger sample sizes are always beneficial when developing an instrument. Once a few additional studies suggest that the validity and reliability of scores are reasonable, intervention research is a logical next step. For example, interventions theorized to change mental models should be positioned as treatments with the Mental Model Style Survey as a pre- and post-test measure. This kind of research can isolate the interventions that can change participant mental models styles -- a useful line of research indeed.

Most research on mental models remains in the abstract, conceptual development domain, and attempts at gathering, accessing, and assessing mental models have proven cumbersome and decidedly qualitative (Dudzinska-Przesmitzki & Grenier, 2009). This research has proposed an alternate method of measuring mental model styles and has resulted in an instrument measuring mental model styles in contexts related to organization performance and change.

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Appendix A. The reduced Mental Model Style Survey (MMSS).

MENTAL MODEL STYLE SURVEY

Use the checklist below to assess your own mental model style in the context of your organization and work responsibilities.

Name _____

[[add demographic information as required for research project]]

Complete the following statements by indicating how you view the organization in which you work.

When considering my organization...

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
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MENTAL MODEL STYLE

1	Organizations are primarily forums for political maneuvering.	1	2	3	4	5
2	Managers should do what is necessary to meet and exceed the expectations of senior managers.	1	2	3	4	5
3	Negotiating a personal agenda is my core purpose in my organization.	1	2	3	4	5
6	The most important metric of organizational health is the balance sheet.	1	2	3	4	5
7	The main goal of organizations is to provide financial return on investment to shareholders.	1	2	3	4	5
10	People are a resource that can be quantified in organizations.	1	2	3	4	5
11	Providing the highest quality output with the most efficient process should be the main goal of any organization.	1	2	3	4	5
12	Organizations are primarily productive, efficient entities.	1	2	3	4	5
13	The most important managerial goals is to ensure that processes run as smoothly and efficiently as possible.	1	2	3	4	5
17	I view organizations primarily as social entities in which people can connect with other people.	1	2	3	4	5
19	The most important metric of organizational health is the level of satisfaction reported by employees.	1	2	3	4	5
20	People and their social connections are what make organizations possible.	1	2	3	4	5
22	Organizations are complex entities.	1	2	3	4	5
24	Assessing organizational health is a complex task involving multiple measures.	1	2	3	4	5
25	People are critical components in the complex organizational system.	1	2	3	4	5

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