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KNOWLEDGE MANAGEMENT PRACTICES IN HIGHER EDUCATION INSTITUTES: A DIFFERENT APPROACH

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Abstract

A wide variety of organizational practices have been proposed to support the creation, storage and transfer of knowledge, yet it is often unclear how these practices relate to one another in their contribution to organizational performance. This study develops a categorization system for knowledge management practices in higher education based on two dimensions: the practices' role in the problem-solving process, and the type of problem they address. Analysis of survey data supports the proposed framework and uncovers two higher order factors that correspond to the concepts of exploration and exploitation. By focusing attention on the importance of problem-solving in transforming knowledge into business value, this research suggests a new way to

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understand the connection between knowledge management practices and organizational goals.

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Introduction

One of the most significant advances in management research occurred in the past decade is the development of a body of language, ideas and models that describe practices for managing organizational knowledge. Researchers and practitioners have proposed a wide variety of practices to support the creation, storage and propagation of knowledge within and across organizations. Gray and Chan (2000) advance a framework that seeks to categorize and integrate these practices into a single model based on the view that the problem-solving process is a vehicle for connecting knowledge and performance – knowledge can generate economic value when it is used to solve problems, explore opportunities and make decisions. Understanding the contribution of various knowledge management practices to problem-solving may help integrate the diverse thinking in this area. This article describes an empirical test of Gray and Chan's integrating framework.

The importance of acquiring new knowledge to enhance organizational competitiveness is now well established. The emergence of the resource-based view of the institute has brought with it a focus on capability, competency and innovation as keys to building successful organizations (Barney, 1991; Cohen & Levinthal, 1990; Prahalad & Hamel, 1990). An institute's ability to compete is increasingly seen as being rooted principally in the skills and knowledge of its employees. Rapidly evolving business environments, however, tend to decrease the useful life span of such skills and knowledge; organizations must therefore continuously adapt to the environment with which they co-evolve in order to maintain their fitness for survival (D'Aveni, 1994).

A necessary but not sufficient pre-requisite for effective organizational adaptation over time is that some subset of employees understands the changes occurring in the organization's environment (Gray, 2000). By developing an understanding of such changes, employees improve their knowledge; this is commonly thought of as learning. Organizations that operate in rapidly evolving environments therefore stand to benefit most from learning, and suffer most from a lack thereof. At the extreme, a lack of learning can prevent an organization from adapting its core

competency to new market conditions; instead, it can become a core rigidity that seriously hampers effectiveness (Leonard-Barton, 2006).

The management of knowledge from a variety of perspectives is addressed by a considerable body of literature. For example, authors have discussed the use of information systems (e.g., Davenport & Prusak, 2008; Ruggles, 1998; Stein & Zwass, 1995), social networks (e.g., Constant, Sproull, & Kiesler, 2006; Nahapiet & Ghoshal, 2008; Rice, 2007), communities of practice (e.g., Brown & Diguid, 1998; Lave & Wenger, 1991), organizational design (e.g., Miles & Snow, 1995; Stewart, 1997), work processes (e.g., Davenport, Jarvenpaa, & Beers, 1996), and other forms of organizational practices (e.g., Boisot, 2008; Leonard & Sensiper, 1998; Nonaka, 1994) as methods for managing the creation and/or transmission of relatively unstructured knowledge. A separate research tradition examines the use of structured knowledge representations embedded in technology to enhance decision-making (e.g., Holsapple & Whinston, 2007; Sprague & Watson, 1996), including considerable research into methods and tools for knowledge acquisition (e.g., Boose & Gaines, 2005; Dhaliwal & Benbasat, 1990). Some knowledge management practices are relatively new while others have long histories. Training, for instance, is a well-established practice for transferring knowledge to employees and enhancing their skills, while publishing a directory of employees and their specialized areas of knowledge is a more recent phenomenon. The thread that ties these practices together is their common conceptualization as tools for managers who wish to make more effective use of their organization's knowledge assets.

This article first discusses existing frameworks for categorizing knowledge management practices based on organizational strategy and knowledge characteristics to explain why a problem-solving approach is likely to have value. Section 2 describes the underlying theoretical constructs and integrates them into the research framework. Section 3 details the development of a survey instrument to test the dimensions of the framework. This is followed in Section 4 by an analysis of 63 returned questionnaires and discussion of findings. The article concludes with a summary of the outcomes, limitations and contributions of this research to a new way of understanding knowledge management practices.

Knowledge management frameworks

The two most widespread types of categorization systems for knowledge management practices are grounded in organizational strategy and characteristics of knowledge, respectively. An example of the strategic perspective is the grouping of knowledge management practices into those supporting a strategy of knowledge replication and those supporting knowledge customization (Hansen, Nohria, & Tierney, 1999).

This approach emphasizes the need for corporate strategy to dictate which knowledge management strategy an organization should use (see also Sarvary, 1999; Zack, 1999). While undoubtedly valuable for analysis at the organizational level, this approach provides little guidance for implementing and integrating a set of knowledge management practices.

Perhaps the most often referenced knowledge-characteristics model is Nonaka's (1994). He draws on Polanyi's (1966) description of tacit and explicit knowledge to propose a typology of knowledge creation practices based on the conversion of knowledge from one form to another. The tacit/explicit categories were, however, never intended to be mutually exclusive; in fact, Polanyi (1966) asserts that all explicit knowledge is grounded in a tacit component, making it difficult to disentangle the two. Organizational reality provides many examples of knowledge that is a rich mixture of ideas, contextually relevant facts and expertise. Nahapiet and Ghoshal (2008) have argued that all knowledge processes have a tacit dimension, drawing on Kogut and Zander (1992) to frame a generic model of combinative capabilities that applies to all forms of knowledge. Knowledge characteristics models have advanced thinking in this area tremendously by underscoring the local, situated nature of some knowledge; however, if most organizationally useful knowledge is indeed a synthesis of various types then such models will have limited application in organizational contexts.

The body of literature that exists on decision-making and problem-solving may provide some guidance for the design of organizations to support knowledge creation and transfer. Huber and McDaniel (1986) build on the idea that effective decision-making is crucial for organizations operating in hostile, complex and turbulent environments. Further, they propose that decision-making may form a new paradigm for understanding (and designing) organizations. Huber and McDaniel's (1986, p. 576) definition of decision-making is roughly equivalent to the problem-solving process, which includes such concepts as "the sensing, exploration and definition of problems or opportunities as well as the generation, evaluation and selection of solutions". Because the research model that is tested in this article is derived from constructs that are common to both decision-making and problem-solving theories, no sharp distinctions are drawn between these two literatures. If decision-making is indeed a paradigm for understanding organizations, then it should be possible to explain knowledge management practices in language and concepts drawn from decision-making theory. The research described below has been formulated to test such systematic connections between decision-making theory and knowledge management practices.

Research model

The activity of problem-solving is essentially the same as the activity of understanding. Regardless of whether or not the implementation of a solution is successful, an organization refines its understanding of its environment, increases its absorptive capacity (Cohen & Levinthal, 1990) and improves its ability to react appropriately to future stimuli by attempting to solve a problem. Indeed, failure to arrive at a successful solution may be essential to effective learning and adaptation over time (Sitkin, 2005). In some cases, the problem to be solved has had no impact on the organization; discovering and solving such a problem can be thought of as discovering an opportunity to improve a product, process or approach. Problem-solving is arguably a primary vehicle for learning in organizations; individuals may develop a better understanding of their environment by recognizing, exploring and resolving problems and opportunities (Huber, 1991).

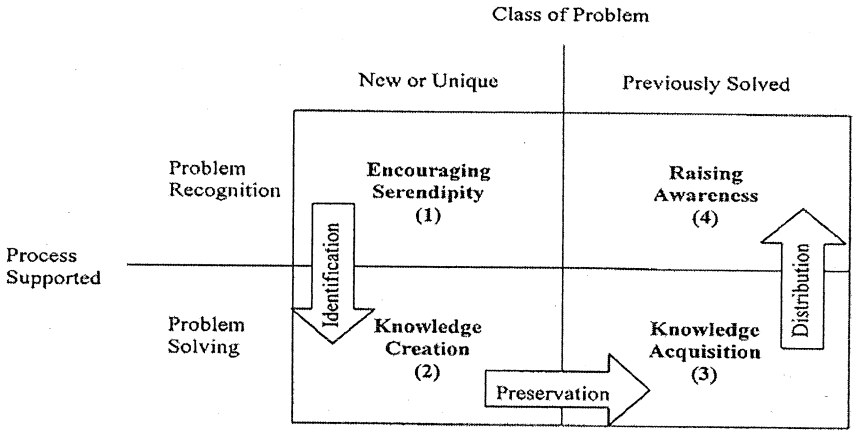

Figure 1. A framework for knowledge management practices

The knowledge management framework (Gray & Chan, 2000) categorizes knowledge management practices according to their contribution to the problem-solving process (see Fig. 1). Empirical validation of this framework would provide support for the connection between knowledge management and decision-making theory and thereby help integrate the various perspectives that exist in this area.

Problem recognition vs. Problem-solving

Decision-making theory has strong roots in the *intelligence–design–choice–implementation* sequence of decision-making (Simon, 1960). The *intelligence* phase involves environmental scanning – individuals searching for stimuli that indicate a need for new actions. Prior to receiving stimuli that call for new action, the individuals in question are by definition unaware of the need for such specific action. Berthon et al. (1998) similarly describe the first stage of the decision-making process as problem perception, a concept that they suggest includes the processes of *scanning*, *noticing* and *constructing meaning* about environmental change. Kiesler and Sproull (1982) frame the process similarly, making distinctions among *noticing*, *interpreting* and *incorporating* stimuli.

This idea that problem recognition must precede problem-solving (or decision-making) appears elsewhere as well. Mintzberg et al. (1976) propose an iterative, multistage decision-making process that begins with an *identification* phase. This concept is similar to Simon's *intelligence* phase, but Mintzberg et al. (1976) decompose it further into two routines: *decision recognition* and *diagnosis*. *Decision recognition* occurs when some stimuli reach a minimum threshold of importance in the view of a decision-maker, creating the belief that action is required. This then leads to *diagnosis*, when the decision-maker attempts to fully understand the stimuli in question.

A number of other authors support the conceptual separation between problem recognition and problem-solving. For example, Schneider and Shiffrin (1977) make this distinction in their discussion of information-processing modes. Problem-solving corresponds closely to their *controlled* mode, reflecting effortful and conscious control of attention as an individual seeks to develop understanding about a particular problem or opportunity. Problem recognition corresponds to their conceptualization of an *automatic* or *default* processing mode in which decision-makers spread their attention across a variety of inputs, making it more difficult to distinguish an issue from its environmental background. The literature on environmental scanning has often made a similar distinction. El Sawy and Pauchant (1988) characterize managers' information acquisition patterns as either *reactive* or *proactive*, the principal difference being whether or not the manager is aware of a specific problem to be solved. Zmud (2003) characterizes managers on a similar problem-awareness continuum, labeling them as *scanners*, *trackers* or *probers*. Vandenbosch and Higgins (1996) also distinguish between *scanning* and *focused* searches.

The distinction between the recognition of the existence of a problem (or opportunity) on the one hand and purposeful actions taken to solve a problem (or exploit an

opportunity) on the other forms the basis of one dimension of the research model. Based on the justifiable presumption that no organization exists in a state in which it is entirely free of both potential and actual problems and opportunities, it seems clear that organizations stand to benefit from implementing practices that support both problem-recognition and problem-solving efforts on the part of their members. The vertical axis of the research model therefore distinguishes between organizational practices that support *problem-solving* and those that support *problem-recognition*.

Novel problems vs. Previously solved problems

The horizontal axis of the research model is termed *class of problem*; it distinguishes between organizational practices that support the identification and resolution of *new or unique* problems and those that deal with *previously solved* problems. It is important to remember that the focus is on categorizing organizational practices, not organizational problems. The fact that many problems require both the generation of some new knowledge and the application of some pre-existing ideas does not change the fact that an organization must support practices to address both elements.

Conceptually, this distinction corresponds to the contrasting of *routine* and *non-routine* problems (1980) and *familiar pattern* vs. *new pattern* (1984) Maier (1945) similarly categorizes problem-solving strategies as either *reproductive* or *productive*, with the former referring to the use of existing rules to solve a problem, and the latter referring to the generation of new rules to deal with novel problems. Mintzberg et al. (1976) also discuss the difference between searching for *ready-made solutions* and developing *custom solutions*, which they suggest is derived from the distinction between convergent and divergent thinking. Clearly, this dichotomy is widely substantiated. The horizontal axis of the research model therefore delineates between organizational practices that support the development of new knowledge in response to *novel* problems and those practices that support the re-use of existing knowledge when dealing with *previously solved* problems.

The knowledge management framework

Gray and Chan (2000) combine the two dimensions described above – problem type and process supported – to form a typology that groups organizational knowledge management practices into four categories (see Fig. 1).

The cells are numbered to reflect a sequence of organizational knowledge flows between cells (discussed below). The top two cells (1 and 4) represent organizational practices designed to raise individuals' awareness of problems and opportunities. The bottom two cells (2 and 3) deal with organizational practices that assist individuals who are aware of a problem or opportunity and are actively attempting

to find or develop a solution. The leftmost pair of cells (1 and 2) corresponds to knowledge creation practices as employees discover and resolve new problems or opportunities. Finally, the rightmost pair (3 and 4) encapsulates knowledge sharing practices used to generate awareness of and propagate knowledge about previously solved problems or issues.

Cell 1, therefore, represents knowledge management practices that encourage employees to discover new problems and opportunities by exposing employees to new information, situations, issues and ideas. Through these practices, the organization tries to create conditions conducive to making valuable unplanned discoveries. In Cell 2, organizations support the active creation of knowledge by employees who are aware of a new problem or opportunity and who are developing novel solutions. Such practices challenge employees to seek creative and innovative solutions to organizational challenges. In Cell 3, organizations engage in practices that capture and retain knowledge, making it available to employees who are seeking solutions to previously solved problems. Technology is often a key feature of these knowledge retention practices. Lastly, in Cell 4, organizations undertake activities designed to help employees realize they may be facing problems or opportunities the organization has previously addressed and for which solutions have been developed. Such practices may also include raising employee awareness about solutions developed by organizational allies, competitors or possibly even best practices from completely different industries.

Gray and Chan (2000) also hypothesize three processes that connect these four cells. First, the *identification* process manages the flow of recognized opportunities and problems from Cell 1 to Cell 2. An organization benefits when it systematically brings to light previously undiscovered problems and new opportunities. This process reveals gaps in organizational knowledge, allows managers to evaluate those gaps, and ultimately can trigger knowledge creation. Next, the *preservation* process creates value by recording newly created knowledge in the organizational memory. A systematic approach to evaluating, classifying, recording and tracking newly created knowledge is at the heart of the preservation process, which corresponds to movement of knowledge from Cell 2 to Cell 3. Last, the *distribution* process involves sharing knowledge that has been recorded in the organizational memory (Cell 3) with appropriate individuals who are likely to benefit from that knowledge but are not aware of any specific need (Cell 4). At the organizational level, this corresponds to processes that periodically extract newly recorded knowledge, package it, target appropriate recipient groups and ensure that it is distributed to them.

This model can also be used to identify a variety of organizational processes that represent other, at times suboptimal, uses of resources. Such dysfunctional processes may seem satisfactory to the individual involved, but do not contribute to

organizational knowledge management. For example, an individual may be made aware of a common problem (Cell 4) but bypass the organizational knowledge base (Cell 3) in his or her search for answers and proceed directly to knowledge creation (Cell 2), thereby re-inventing the wheel. Another example would involve the creation of new knowledge (Cell 2) that is not recorded for future reference in some way (Cell 3), forcing others who face the same problem to duplicate their efforts. In the same way, awareness of new problems or opportunities (Cell 1) that are not subsequently pursued (Cell 2) also results in corporate memory loss.

Method and results

The empirical research described in this section was undertaken to test whether the dimensions proposed in the knowledge management framework enable significant distinctions to be made between different kinds of knowledge management practices. This represents a first step in testing the full model. Should the dimensions prove stable over a variety of settings and practices, further research into the hypothesized cross-cell knowledge flow processes can then occur.

To test the framework, managers were asked in a questionnaire to rank a variety of knowledge management practices according to the model's dimensions. First, generic descriptions of knowledge management practices were produced. Next, a set of items was developed to measure the constructs proposed in the framework. A questionnaire was then constructed by placing a single description at the top of each page followed by the full item set. The questionnaire was validated through a pre-test and a pilot test, and subsequently administered to a group of 150 senior managers (chancellors and vice-chancellors). Responses were analyzed to test whether mean responses to the framework dimensions varied between practices. Detailed descriptions of each of these steps follow.

Knowledge management practice descriptions

Eight individual practices were identified for use in this study through a review of recent literature describing knowledge management practices. Practices were selected for their representativeness of a particular genre of knowledge management concepts. Each was described by more than one author (Brown & Diguid, 1998; Choo, 1998; Crowe,1997; Davenport & Prusak, 2008; Garvin, 1998; Nonaka & Takeuchi, 1995; Quinn, Anderson, & Finkelstein,1998; Ruggles, 1998); common elements were extracted and edited into a single generic practice description. The use of generic descriptions drawn from previously published literature is similar to the use of scenarios in experimental research. Scenarios are outlines of stereotypical problems constructed to describe a complex problem in feasible and understandable terms

(Kirs, Sanders, Cerveny, & Robey, 1989). Generic descriptions are similarly used in this study to provide abbreviated descriptions of the salient features of knowledge management practices in a simplified form. Through a pre-test and pilot test (described below), practice descriptions were modified for improved readability and reduced in number from eight to five. Table 1 provides the five practice descriptions used in the full survey.

Table 1. : Descriptions of knowledge management practices

Practice	Description
Formal training	Employees attend structured sessions where they are provided with instructional material designed to educate them about a particular subject. The training material is often presented by instructors who are experts on the subject material (who may or may not be employees of the institute). Sometimes it is delivered via a computer or videotape without any in-person instruction. Formal training sessions may also include appraisals of the proportion of instruction retained by the learner, and certificates for successful completion of one or more sessions.
Knowledge repositories	Knowledge repositories are structured collections of documents, often written by internal company experts. These documents attempt to capture their author's expertise and insight on a subject. Documents in a knowledge repository are often categorized into separate databases by functional area, project, or other topic, and are indexed to permit easy keyword searching and browsing by employees.
Knowledge fairs	Knowledge fairs are like internal trade shows that are produced by employees for employees. They are relatively unstructured gatherings where employees staff booths, mount displays and talk about their institute's successful practices and products. Knowledge fairs encourage the spontaneous exchange of knowledge between employees who never get to talk to one another in the course of their daily work. Knowledge Fairs bring people together without preconceptions about who should talk to whom, giving people opportunities to wander, mingle, and talk.

Practice	Description
Communities of practice	Communities of practice emerge naturally both within and across organizations. Employees who have a common base of expertise, who deal with a common organizational process, or who have an interest in solving similar types of problems naturally group together to share ideas. Communities of practice provide a context for the informed discussion of problems, new events, and ongoing issues.
Talk rooms	Talk rooms are social spaces which R & D staff are expected to visit for 20 min or so as a normal part of their workday. Meetings are not held here, and there are no organized discussions. The expectation is that the researchers will go to these talk rooms and chat about their current work with whomever they find, and that these more or less random conversations will create value for the institute.

Questionnaire development

Questionnaire items were developed in an iterative manner based on recommendations from Churchill (1979). First, the authors developed a list of 16 candidate items (four each for *problem-recognition*, *problem-solving*, *new problems* and *pre-existing problems)* by conducting a review of the literature dealing with the dimensions of the knowledge management framework. These items were refined through discussions with two university professors and four graduate students; the most contentious item for each scale was discarded.

An initial version of the questionnaire was constructed by placing each knowledge management practice description at the top of a page, followed by the set of 12 items. Items featured a seven-point Likert scale, with response options ranging from "strongly disagree" to "strongly agree". A "do not know" option was also provided for each item to account for the fact that not all respondents would be familiar with all practices. Respondents were asked to read each description and indicate their level of agreement with each item before progressing to the next description. The pre-test was carried out with 16 graduate business students, with a 94% response rate. Items were purified by computing Cronbach's coefficient alpha and by inspecting the correlation matrices of the constructs involved. In addition to assessing item performance through quantitative measures, the authors solicited qualitative feedback to identify items that were confusing or ambiguous to respondents.

Problematic items were modified and the revised constructs used in a pilot study involving 20 professors and managers, which generated an 80% response rate. Similar statistical measures where used to refine items, and qualitative responses helped refine the questionnaire in general.

Data collection

Senior managers from large higher education institutes were selected for this study on the rationale that they would likely have been exposed to a wider variety of knowledge management practices than would non-managers, lower level managers or individuals in smaller institutes (in which more informal knowledge sharing might occur). A total of 150 institutes were randomly selected.

Questionnaire packages were mailed to this target group and followed by up to three rounds of reminders. Messages were left on non-respondents' voice mail after 8 business days, sent via e-mail 6 business days later, and left on voice mail again after 8 additional business days. A total of 63 responses were received, for a response rate of 42%.

As the survey was intended to capture responses from managers, the single non-manager response was deleted from the data. No significant correlations were found between item responses and job category, age or gender.

Findings

An analysis of scale reliability was performed using Cronbach's alpha coefficient and three items were dropped to improve reliabilities. The final scale reliabilities were 0.749 for *problem-solving* (three items), 0.621 for *problem-recognition* (two items), 0.734 for *new problems* (two items) and 0.603 for *pre-existing problems* (two items). These reliabilities exceed Nunally's (1967) suggested minimum reliability of 0.5–0.6 for instruments used in early stages of exploratory research. Given that the square root of coefficient alpha is the estimated correlation of the *n*-item test with errorless true scores, these scales represent estimated correlations with the true score in the range of 79–87% - certainly quite acceptable. Scales featuring this level of correlation can achieve coefficient alpha scores in excess of 0.8 merely by employing more items per scale. Because questionnaire size was problematic in early testing, a trade-off between size and reliability was necessary.

To assess the usefulness of the constructs in classifying knowledge management practices, separate ANOVA tests for differences in responses on each of the four scales were performed. Each ANOVA tested for differences between knowledge management practices on a single scale; in all cases, significant differences in

means were found at the *Pd*"0.001 level. Tukey's Honestly Significant Difference (HSD) tests were performed post hoc on each scale to provide a more detailed depiction of the scale's ability to differentiate between practices; results are shown in Appendix A. While three of the four scales were not able to separate practices dichotomously into two separate groups, each scale did indicate a majority of practices as being above or below average in relation to the overall mean response. The discriminatory power of the four dimensions is therefore clearly substantiated.

Although the knowledge management framework features four constructs, it proposes two underlying dimensions: *process supported* and *class of problem*. These dimensions were tested by contrasting standardized scales (REC vs. SOL for the former, and NEW vs. PRE for the latter) as shown in Table 2. Four out of five practices featured responses significant at the $P \leq 0.05$ level, while one practice featured no responses significantly different from the mean. These results support the usefulness of the research model in classifying knowledge management practices. Further, they suggest that managers do employ a classification system that is reflected in decision-making and problem-solving theory.

Table 2. Paired contrasts of standardized scales

Practice	Contrast	Contrast mean	Significance (two-tailed)
Formal training	PRE–NEW	0.4672	0.05
	SOL–REC	0.3251	0.04
Knowledge repositories	PRE–NEW	1.5000	0.00
	SOL–REC	1.7151	0.00
Knowledge fairs	PRE–NEW	-0.3305	0.01
	SOL–REC	-0.6864	0.00
Communities of practice	PRE–NEW	-0.1694	0.37
	SOL–REC	0.0484	0.73
Talk rooms	PRE–NEW	-1.1048	0.00
	SOL–REC	-0.8844	0.00

Fig. 2 depicts these results visually by using contrast means as coordinates for locating practices in the knowledge management framework.

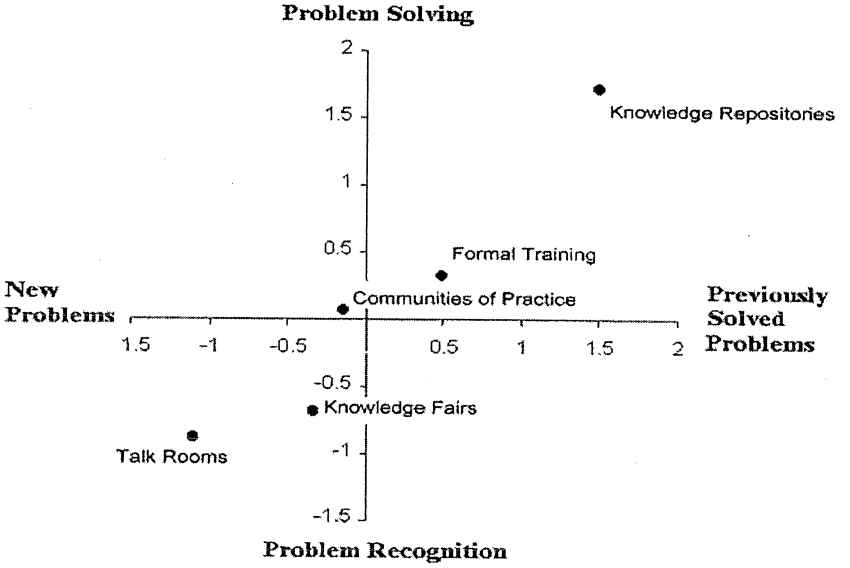

Figure 2. Paired contrast means

The diagonal linear pattern that emerges in this process may have a number of different meanings. First, it is possible that the practices selected for use in this research were naturally grouped into the upper-right and lower-left quadrants. Although such a grouping was not intended, it may have been inadvertently created during practice selection. Different practices may generate data points in the largely empty quadrants; only further research will substantiate or disprove this hypothesis.

A second possible cause for this diagonal pattern is that the responding managers do not think in terms of the recognition of pre-existing problems or the solving of completely novel problems. In the former case, managers may assume that individuals who need to solve a common problem will simply do so when that problem is recognized in the normal course of events, and that organizational practices cannot improve the recognition of problems. Similarly, managers may apply an overly rational paradigm when addressing novel problems, presuming

that once a new problem is recognized its solution is obvious. Such an approach would downplay the need to explore possible alternate solutions. Another possible explanation for managers' lack of focus on these two quadrants lies in the nature of the managers surveyed; relatively few managers reported titles that directly linked them to departments that commonly grapple with novel problems (such as research and development or engineering).

However, a third possible cause of such a diagonal pattern can be argued: quite simply, it is that the constructs underlying the data are different from those hypothesized in the research framework. A principal component analysis was performed on the response data to test this possibility. Two components emerged, accounting for 57% of the variation observed (see Table 3). The first component included all items from the *problem-solving* and *pre-existing problems* scales. It can be thought of as the extent to which activities help employees solve conventional problems and so was termed "Solving Recurring Problems". The second component included all items from the *problem-recognition* and *new problems* scales and was, therefore, termed "Recognizing New Problems".

Table 3.Principal components analysis

Item	Component	
	1	2
SOL2	0.777	
SOL3	0.770	0.165
PRE1	0.753	-0.159
SOL1	0.703	0.239
PRE2	0.649	-0.184
NEW1	0.117	10.843
NEW3		0.758
REC1		0.711
REC2		0.705

These components seem to correspond to March's (1991) ideas of *exploitation* and *exploration*, respectively. March asserts that the relationship between the exploitation of old certainties and the exploration of new possibilities is a central concern of studies in adaptive processes. In his words:

> Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution. Adaptive systems that engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of experimentation without gaining many of its benefits. They exhibit too many undeveloped new ideas and too little distinctive competence. Conversely, systems that engage in exploitation to the exclusion of exploration are likely to find themselves trapped in suboptimal stable equilibria (March, 1991).

Were managers consciously or subconsciously employing the exploration–exploitation dichotomy in their assessment of knowledge management practices? If so, this would imply some sort of negative relationship between responses to these two components; practices that scored high on one should therefore score low on the other. Fig. 3 depicts the placement of practices on these dimensions; the origin (0,0) represents the mean response for EXPLOIT (Component 1 in Table 3) and EXPLORE (Component 2). A negatively correlated linear pattern is apparent in this data; practices that scored higher in one dimension generally scored lower on the other, and vice versa.

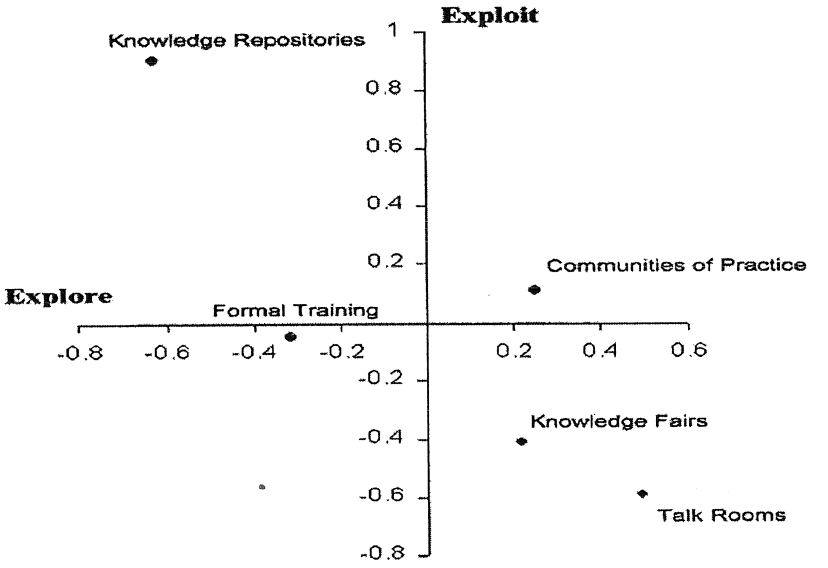

Figure 3. Standardized EXPLORE and EXPLOIT constructs

Only further research can substantiate the underlying cause(s) behind the observed linear pattern in the response data. Replication of this research using practices representing the off-quadrants could improve the robustness of the hypothesized constructs. Alternately, replication using the original knowledge management practices but involving a group of managers involved in engineering or research and development functions could provide additional insight. Lastly, a line of investigation to specifically test the *exploration* and *exploitation* constructs might provide additional confirmation of the usefulness of this higher order classification system for knowledge management practices.

Discussion

This study contributes to the literature on knowledge management by uncovering systematic connections between knowledge management practices and decision-making theory. The survey provides substantive, statistically significant evidence supporting the hypothesis that knowledge management practices vary along two continuums in their contribution to decision-making. By demonstrating that knowledge management practices can be distinguished from each other based on their role in decision-making, this research underscores the importance of knowledge as a resource that is tapped through organizational decision-making and problem-solving processes.

The finding of higher order constructs representing *exploration of new possibilities* and *exploitation of existing resources* sheds additional light on the role of knowledge management practices in organizations. Increasing environmental turbulence suggests a need for more exploration, which may indeed be the driver for an entire class of knowledge management practices focused on knowledge creation. *Exploration* is thus a tool for differentiation (Porter, 1985). At the same time, the reduction in structural barriers to competition may be forcing institutes to refine their exploitation activities with a focus on efficiency that underscores much of the literature on knowledge sharing and re-use. Such a focus helps an institute compete on the basis of cost (porter, 1985). The *exploration–exploitation* dichotomy therefore represents another, somewhat broader, classification tool, which stands to provide further theoretical support for the relatively unstructured knowledge management area – in effect, a superset of the research model.

The literature on decision-making and decision-support has been largely ignored in the recent surge of interest in organizational learning and knowledge management. Huber (1991) asserts that an organism has learned if it experiences a change in its range of potential behaviors. While broadening the range of potential outcomes is important, perhaps the key to organizational performance lies in the

decision that selects one outcome over another. The finding that distinctions derived from decision-making theory are useful in the identification of significant common characteristics of knowledge management practices brings us one step closer to the integration of decision- making theory with the emerging literature on knowledge management.

Limitations

As with any exploratory research, this study is subject to a number of limitations. Perhaps the most significant of these is the sample employed; that senior managers in large universities believe their employees to be experiencing certain kinds of learning while engaged in different knowledge management practices does not substantiate that such learning is actually occurring. There is no assurance that managers are familiar enough with these practices to act as knowledgeable key informants. Yet, their responses form an important indicator of the *purpose* of these knowledge management practices in the eyes of individuals who ultimately are responsible for directing and supporting such practices. A study of employees who have participated in these activities might confirm or disconfirm these findings; in the latter case, the specific ways in which employees' experiences differ from managerial perceptions might be a very useful diagnostic for assessing the relationship between a practice's intended and actual effects.

The second limitation of this study is the potential for bias inherent in the within-subjects comparison technique. A larger survey in which respondents receive only a single scenario accompanied by more detailed questionnaires including more items per construct would stand as a replication and refinement of this study. A third limitation was alluded to earlier in this article: the use of a limited set of scenarios. Replication of this study with a different set of scenarios stands to improve our understanding of the constructs underlying the research model. A final limitation is the item measures used; beyond exploratory research, they will need to be refined to improve reliability for ongoing research.

Conclusion

The management of organizational knowledge creation and distribution stands to leverage the most important asset of the 21st century organization – its knowledge. While others have discussed the linkage between problem-solving, adaptation and performance, this research demonstrates the relevance of problem-solving and decision-making theory in assessing the *purpose* of organizational knowledge management activities. The problem-solving process is the vehicle for connecting knowledge and performance; knowledge gains economic value when it is used to

solve problems, explore opportunities and make decisions that improve performance. By focusing attention on this important linkage, this research suggests new ways to conceptualize knowledge management practices.

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