Measuring knowledge in organizations: a knowledge-in-practice approach

Derrick McIver and Xiaodan "Abby" Wang

Derrick McIver and Xiaodan "Abby" Wang both are Assistant Professors of Management both at Western Michigan University, Kalamazoo, Michigan, USA.

Abstract

Purpose – *This paper aims to develop a reliable and valid scale for measuring the underlying knowledge involved in work. To do so, it builds on the knowledge-in-practice (KIP) framework that suggests different types of work have different underlying knowledge characteristics. This allows us to answer two important questions: What are the underlying characteristics of KIP that are important to effectively manage a firm's knowledge resources? How do we measure these characteristics? The answers help to build theoretical and empirical understanding of the construct of KIP.*

Design/methodology/approach – *The study uses a discovery-oriented survey design methodology to design the survey instrument, followed by a mixed-methods approach to validate the scale.*

Findings – *A new scale is developed for measuring the tacitness and learnability of the knowledge involved in work. It allows work units to be evaluated based on the underlying knowledge involved in different types of work.*

Research limitations/implications – *The KIP scale can be used for measuring the type of knowledge characteristics in organizations. Academics can use this study as a basic model to explore knowledge across different contexts and focus on the different characteristics within and across work contexts.*

Practical implications – *The study provides a clearer and more granular understanding of knowledge in organizations that can be used as a guideline to refer to when measuring and assessing knowledge requirements.*

Originality/value – *Scholars have pushed to understand work from a knowledge and collaboration perspective. A measurement scale for the KIP framework provides a critical first step towards this outcome.*

Keywords *Knowledge management, Tacit knowledge, Knowledge-based systems, Knowledge workers, Knowledge-driven organizations, Knowledge-in-practice*

Paper type *Research paper*

1. Introduction

As organizations, industries and societies become increasingly knowledge- and information-intensive, theories and methods for understanding knowledge become increasingly important. The knowledge-based view (KBV) highlights knowledge as the most strategically significant resource of the firm and argues that the foundation of an organization's performance lies in its ability to generate, combine, recombine and exploit knowledge (Dierickx and Cool, 1989; Grant, 1996; Kogut and Zander, 1992).

Research has documented the important role knowledge management (KM) plays in facilitating innovation and product development (Pitt and MacVaugh, 2008), increasing productivity (Wiig and Jooste, 2003), and enhancing operational effectiveness (Hult *et al.*, 2004). The ability to understand the knowledge involved in organizational work and to adopt appropriate KM initiatives has become critical to firms' survival and success. However, we cannot understand and manage things that we cannot measure. Measurement is the basis through which it is possible to understand, evaluate and improve processes. Measurement also helps us achieve important objectives such as optimizing fit

Received 23 November 2015
Revised 29 March 2016
Accepted 4 April 2016

> **"An important challenge is to understand how organizations effectively and efficiently measure and assess knowledge to manage it for value creation."**

between employees and work, providing effective training, achieving high productivity and effectiveness and designing KM systems and initiatives to help drive desirable outcomes.

However, because of its context-specific and multi-dimensional nature, measuring knowledge represents one of the most challenging activities in KM research (Chen *et al.*, 2009). What is measured is usually not knowledge (especially tacit knowledge) itself but some specific attribute relating to the knowledge, for example, the source of knowledge, the domain of knowledge or the level of knowledge complexity. According to Grant (1996), identifying and establishing the characteristics of knowledge that have critical implications for management will provide more value than resolving the long-lasting debate on what knowledge is. However, because of the diverse number of phenomena under the knowledge umbrella, it is important for researchers to be specific about what aspect of knowledge or KM is of interest to them.

To better understand the nature of work being done in today's knowledge economy, this study focuses on examining and measuring the nature of work from a knowledge perspective. By nature of work we mean the underlying knowledge characteristics or knowledge structure of work. An inherent assumption here is that not all work is the same and types of work can be differentiated based on characteristics of the underlying knowledge involved. By examining the characteristics of knowledge underlying a work context, we can distinguish between different types of practices needed to get work done in different business units. Understanding, assessing and measuring work from a knowledge perspective can benefit research in strategic management, human resource management, organizational theory and KM. It can also provide an alternative theoretical approach and guideline for organizations and managers as they look to invest in KM initiatives.

Specifically, we develop a reliable and valid scale for measuring the knowledge-in-practice (KIP) framework that articulates characteristics of knowledge with important implications for organizational work (McIver *et al.*, 2013; Ragab and Arisha, 2013). This approach allows us to answer two questions:

Q1. What are the underlying characteristics of knowledge-in-practice that are important to effectively manage a firm's knowledge resources?

Q2. How do we measure these characteristics of knowledge-in-practice?

The results of this study ultimately provide important insights regarding how organizations and researchers can understand knowledge involved in work practices and thereby provide useful implications for future research and practice.

2. Characteristics of knowledge

The ontology of knowledge including definitions, types and characteristics of knowledge has been a controversial topic since ancient Greek philosophers debated it (Ragab and Arisha, 2013). This debate has produced a range of definitions, taxonomies and classifications, including tacit/explicit, individual/organizational, internal/external, structured/unstructured, objective/subjective and embroiled/embodied/encultured/embedded/encoded (Ragab and Arisha, 2013) The most widely used taxonomy is Polanyi's (1966) tacit and explicit knowledge. Explicit knowledge is that which can be codified, while tacit knowledge is less codifiable and lies in an individual's experience and judgement (Nonaka, 1994). Following this seminal work,

researchers have produced many definitions and varying interpretations as to what tacit and explicit knowledge are, and how they are interrelated (Oguz and Elif Sengün, 2011).

Our perspective is that debates about the nature of knowledge will continue and are unlikely to be resolved. Ragab and Arisha (2013) suggest that the debates continue because of the philosophical and subjective nature of the topic. Others such as Grant (1996) suggest avoiding the debate and instead focusing on the characteristics of knowledge that have implications for management. From a different perspective, resolving this debate is most likely to provide only a small benefit, and could unnecessarily limit our understanding of organizations and management. It would be more useful to think of knowledge as having many different characteristics and the literature as examining many different phenomena under an umbrella construct of knowledge. As such, treating knowledge as an umbrella term with many subparts in need of deconstructing, rather than a topic of debate with a single truth, is likely to result in valuable insights to research and practice.

In this manuscript, the focus is specifically on the measurement and examination of work practices. At a more granular level, it is the nature of the knowledge involved in work practices referred to by McIver *et al.* (2012, 2013) as KIP. This push stems from recent research in organizations and strategic human resource management that focus on segmenting work to understand critical differences between work practices and units in order to benefit both employees and organizations (Cascio and Boudreau, 2010).

2.1 Characteristics of the knowledge-in-practice framework

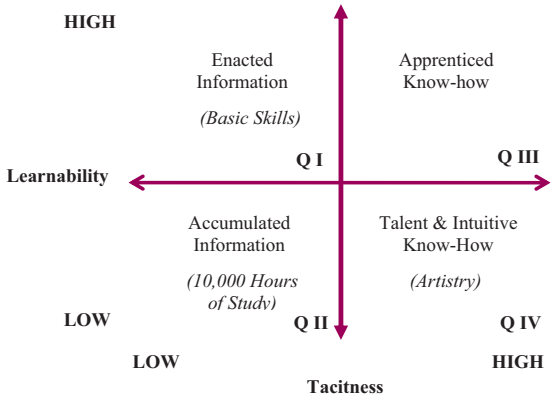
Understanding work in the twenty-first century means that work needs to be viewed from a knowledge perspective as we examine capabilities or activities – in this case, the work done in various organizational units. Organizational units vary in many ways including by the type and kind of work they do both within and across organizations. Ultimately, different organizational units rely on distinct types of knowledge to perform their work activities. These differences are important because they define the embedded context of organizational work. Identifying and measuring the underlying knowledge characteristics required for the work activities or practices a unit performs can be a useful way to distinguish one unit from another and inform research as well as a variety of management and organizational decisions (McIver *et al.*, 2013).

The term *practice* is used to refer to "the way in which work gets done and knowing how to do it" (Brown and Duguid, 2001, p. 200). Practice is an inclusive "unit-level" term that identifies the level of theoretical and practical relevance, as the relevant level of aggregation across practices can vary (Ployhart and Moliterno, 2011). McIver *et al.* (2012, 2013) define KIP as the information and know-how involved in the sequences, routines, capabilities or activity systems in an organization. *Information* refers to facts and data that can be understood, stored and transferred (Kogut and Zander, 1992; Winter, 1987), and *know-how* refers to skills and expertise that are action-based (Cook and Brown, 1999; Polanyi, 1966). Essentially, KIP offers a way to articulate the underlying knowledge characteristics of a unit.

Both information and know-how incorporate dimensions of knowledge tacitness and learnability (McIver and Lengnick-Hall, 2011; McIver *et al.*, 2010). Figure 1, adopted from

"It would be more useful to think of knowledge as having many different characteristics and the literature as examining many different phenomena under an umbrella construct of knowledge."

Figure 1 KIP for organizational work Adopted from McIver *et al.* (2012, 2013).



Adopted from McIver *et al.* (2012, 2013)

McIver *et al.* (2010, 2013, 2012), depicts the multidimensional framework used in this study in which KIP is conceptualized in terms of its variation along tacitness and learnability continuums.

Drawing from the work on communities of practice researchers (cf. Brown and Duguid, 2001; Cook and Brown, 1999; Duguid, 2005; Lave and Wenger, 1991), tacitness is defined as *the degree to which the know-how involved in an organizational practice is unobservable, difficult to teach, unspecifiable, and/or highly embedded in the setting* (McIver *et al.*, 2013). Both the proportion and role of tacitness varies with different types of KIP. This is different and potentially contrasting with views that tacit and explicit knowledge are opposite ends of a continuum in which tacit can be converted to explicit knowledge. In KIP, the tacitness dimension captures the proportion of tacit know-how relative to the degree of articulated or explicit information underlying the knowledge in particular types of work.

The second dimension, learnability, is defined as *the type and amount of effort, study, accumulated comprehension and expertise that is involved in understanding the information and know-how for accomplishing work practices* (McIver *et al.*, 2013). Learnability captures the ease (or difficulty) that new or occasional workers experience while trying to perform certain work practices. Learnability distinguishes between KIP that is difficult to learn and KIP that is relatively easy to learn regardless of the underlying degree of tacitness. This dimension highlights two often overlooked conditions – KIP with a high degree of tacitness that is easy to learn and KIP with a low level of tacitness that is quite difficult to learn. This distinction addresses an implicit, but arguably inaccurate, assumption that all tacit knowledge is difficult to learn. This is in line with Snowden's Cynefin model that differentiates between complicated knowledge and complex knowledge (Snowden, 2002).

In summary, the learnability and tacitness of a unit's KIP provides a way to distinguish the underlying knowledge characteristics of work contexts. When these dimensions are combined, they yield four practice types:

1. enacted information (high learnability, low tacitness);
2. apprenticed know-how (high learnability, high tacitness);
3. accumulated information (low learnability, low tacitness); and
4. talent and intuitive know-how (low learnability, high tacitness).

These distinct practice types distinguish one unit from another based on the underlying characteristics of the primary work activities (McIver *et al.*, 2013; McIver and Lengnick-Hall, 2011).

> **". . . the learnability and tacitness of a unit's KIP provides a way to distinguish the underlying knowledge characteristics of work contexts."**

3. Methodology

Because of the exploratory nature of the study, an initial problem was discovering the appropriate level of analysis for the KIP phenomena and extracting how this phenomenon manifests itself in organizations. This involved a multi-step process driven by logical qualitative and quantitative analysis. A first step was to identify a research context that would allow for the examination of the knowledge underlying work.

Hospitals provided a setting to conduct the research and scale development for two reasons. First, a broad range of different types of work is undertaken in hospitals, such as emergency room surgery, trauma work, financial analysis, kitchen work and environmental services. This variability is necessary to study the underlying knowledge types of work practices.

The second benefit was the clear separation of functioning units. A review of organizational charts and observation of work processes and procedures showed that work practices were sub-divided into definable roles and units. Specifically, organizational structures and established subordinate–supervisor roles permitted a clear separation of units within health-care organizations based on the work practices performed. This allowed for data collection at the unit level. Although this is a benefit captured in our research, it also may need to be a requirement of knowledge research moving forward. Simply distributing surveys or using archival data as proxies for knowledge without paying attention to the level of analysis may misrepresenting constructs and knowledge phenomena. This also includes understanding and not just controlling for industry differences. Because an assumption is made that work practices can vary within a single organization, the unit of analysis is the organizational work unit. Kozlowski and Klein (2000) discussed the need for researchers to clearly delineate the level of theory and measurement in their research. In this study, both theory and measurement reside at the unit level, so all survey items were worded at the unit level.

3.1 Sample and unit level of analysis

As already mentioned, we measure two continuums of knowledge involved in practices: learnability and tacitness. Each of these components are multi-dimensional and can have a large number of items for which there might be underlying latent constructs. As Salk and Simonin (2002) argue, before any advancement can be made in understanding KM, researchers need to focus on the operationalization of knowledge-based constructs to ensure we are adequately measuring our desired phenomena and constructs.

After selecting hospitals and learning about their unique characteristics of work, we chose seven hospitals that would allow us to capture diverse work practices and KIP contexts across units both within and between hospitals. Because the label "unit" can be used to describe work configurations that vary greatly in the extent to which workers actually function as a distinct group, each organization and participating unit included in our sample was carefully analyzed. First, before surveys were sent out, meetings and phone interviews were set up with either a human resource (HR) management employees or employees from the hospitals' research departments to obtain an overview of each organization's structure. With the assistance of these employees, a definable list of units was created for each organization. Employees from within the departments helped verify

each list and ensure its accuracy. These individuals were asked to confirm that both managers and employees working in the hospital would be able to identify the unit in which they work.

Participants were recruited through a contact from HR at each facility. Individuals were first contacted two weeks before the survey was administered with an email from an HR representative informing them that:

- a study was being conducted;
- their voluntary participation would be appreciated; and
- they would receive an email invitation to take an online survey.

The same individuals received a second email sent from the HR representative directing them to a website containing an informed consent form and instructions on how to participate. After agreeing to participate, employees were directed to the survey. A one-page survey was used to maximize response rates and encourage participation.

To obtain the KIP context variables, employees in non-supervisory roles were directed to an employee survey and asked to complete questions about their work activities and characteristics of the unit in which they work. Two weeks after the initial emails were sent, the HR representatives sent a reminder email asking those who had not yet participated to do so. The intent was to use all units within each of the seven participating health-care organizations. Because a number of people work in each unit, responses from at least four employees within a unit were needed to qualify the unit for inclusion in the study. The four-person cut-off was necessary to ensure survey participants were kept anonymous and to be sure aggregation statistics could be calculated with precision (Lindell and Brandt, 1999; Lindell *et al.*, 1999).

We received 1,245 usable employee responses (30.3 per cent response rate). After matching employees within each unit that provided at least four responses with managerial responses, 448 employee surveys were eliminated. A total of 797 useable employee responses remained. This resulted in a total of 171 different units (Table I).

To examine potential response bias, employee ratings of the knowledge context variables of units that had less than four respondents were compared with those from units with more than four responses. A *t*-test showed no significant differences ($p < 0.05$) between the two groups based on volume, ambiguity, codifiability or observability of KIP contexts. Also differences between those who responded to the initial request were compared to those who responded after two weeks. These comparisons did not reveal any significant differences ($p < 0.05$), indicating response bias was unlikely to be an issue.

3.2 Questionnaire development

To generate items for scale development, we used a two-stage development process with an academic phase and a practitioner phase. This approach follows a discovery-oriented approach, where a theoretical perspective (academic phase) is supplemented with field-based perspectives (practitioner phase) by involving experienced advisors from practitioner settings.

Table I Survey response rates

Items	*Employees*
Total	4,108
Responses	1,245
Response rate	30.31%
Eliminated	448
Result	797
Number of aggregated units	171
Final Response rate	19.40%

3.2.1 Phase 1. Scale development started with a literature review from which a pool of items was generated for each construct. This first step began with in-depth research, including reviews of practitioner and academic literature and interviews with personnel working in the area. These initial items were refined and adapted through conversations with academic faculty familiar with the area of research. One of the issues raised in this phase was the potential influence of industry-specific characteristics of health-care impacting the survey. To account for and alleviate this problem, we conducted research and interviews with personnel working within research centres at various hospitals and with academics teaching and researching at nursing schools. These steps provided familiarity with industry-specific issues and terminology. This understanding enhanced credibility and enabled richer and more probing questions to be asked during discussions with industry experts.

An initial draft of the questionnaire was designed using a combination of items taken from prior studies and original items based on issues uncovered in the field interviews. All items from previous studies were adapted and reworded to reflect the unit level of analysis.

3.2.2 Phase 2. During the second phase, we administered the initial survey to a small number of management faculty and health-care researchers. The main objective of this phase was to establish the face validity of the KIP measures and to narrow down, select and refine appropriate items. Qualitative feedback was collected through one-on-one meetings and emails with a subset of respondent scholars and practitioners. These scholars were encouraged to think aloud and verbalize the logic they followed when reviewing the items. Important concerns discovered in this phase were taken into account to make further modifications to the survey, resulting in the final list of items in Appendix.

3.3 Data aggregation

To capture the unit level of analysis, individual employee responses were aggregated to the unit level, providing a more reliable measure of the KIP unit-level constructs (Bliese, 2000). Because of strengths and weaknesses of various interrater agreement measures, both the intraclass correlations statistics ICC(1) and ICC(2), and the interrater agreement statistic $r^*_{wg(J)}$ (Lindell and Brandt, 1999; Lindell *et al.*, 1999) were computed. Appendix shows the values of these statistics for each of the measures. Overall, the high interrater agreement and scale reliability (Cronbach's alpha) justified the combination of individual employees' responses into aggregated measures for the KIP variables for each unit. Specifically, ICC(2) values ranged from 0.87 to 0.91 which are high and well above the 0.60 cut-off recommended by Glick (1985). The $r^*_{wg(J)}$ values across all units with four or more responses per unit ranged from 0.73 to 0.86 which are above the commonly accepted cut-off of 0.70 (George, 1990). The high $r^*_{wg(J)}$ values showed that the ratings from individual employees within a unit are highly interchangeable, that is, employees from the same unit essentially provided the same ratings. Thus, the interrater agreement and intraclass correlation statistics provide sufficient support for aggregating data to the unit level of analysis.

3.4 Constructs and measures

The framework we use to measure KIP suggests that the dominant KIP of a unit is based upon two dimensions: tacitness and learnability. Each of these dimensions falls along a continuum and is assessed by the information and knowledge involved in typical everyday practices undertaken by workers in a unit. Work units then can be categorized based on their KIP characteristics, which is determined by the levels of tacitness and learnability.

As Kogut and Zander (1995) argue, it would be illogical to believe that there is a single dimension called tacitness. Likewise, it would be illogical to believe that there would be a single dimension called learnability. Thus, to measure the characteristics of a unit's KIP, it was important to measure a number of dimensions of the actual work practices being performed. The final survey items were ultimately adapted to focus on the nature of KIP in

general health-care facilities. This use of perceptual responses is quite common in KM research (Simonin, 2004; Lane *et al.*, 2001).

A confirmatory factor analysis including all KIP measures was performed to validate the final measures. The final items from the refined instrument including their factor loadings, reliabilities and aggregation measures are shown in Appendix. A model with four distinct measures (with two tacitness dimensions and two learnability dimensions) capturing a unit's KIP (with each item constrained to load only on the factor for which it was a proposed indicator) yielded a model that fit the data moderately well (χ^2 (84) = 193.2, $p < 0.001$; GFI = 0.87; CFI = 0.92; RMSEA = 0.087). The chi-square statistic is significant ($p < 0.001$), indicating a poor reproduction of the covariance matrix. However, the chi-square statistic is sensitive to sample size and may erroneously imply a poor data-to-model fit. To make it less dependent on sample size, we calculated the relative chi-square (the chi-square fit index divided by degrees of freedom). The relative chi-square statistic of 2.3, which lies in the range of 2-3 indicates a reasonable fit between the hypothesized model and the sample data (Carmnines and McIver, 1981) and is far below the cut-off point of 5 recommended by Marsh and Hocevar (1985). The comparative fit index (CFI) is a common goodness-of-fit (GFI) index that is not sensitive to sample size. The CFI value of 0.92 is above the widely acceptable cut-off point of 0.9, indicating a good model fit (Rigdon, 1996). In addition, at 0.87, the GFI index is a little bit below the recommended minimum of 0.9, suggesting a less satisfactory model fit (Hair *et al.*, 1995). Similarly, RMSEA values of 0.08 or less indicates a reasonable error approximation and models with a RMSEA greater than 0.1 should not be used Browne *et al.* (1993). Although a RMSEA of 0.087 does not meet the 0.08-or-less criterion of adequate fit, it is below the more liberal cut-off point of 0.1, providing support for the model.

Overall, these statistics show that the model is acceptable. Furthermore, the model with four distinct measures was a significant improvement over alternative models with one general factor (KIP) or with eight different factors.

3.5 Tacitness

The employee survey measured tacitness of a unit's KIP context in terms of the degree to which information and skills needed for work practices are difficult to observe, teach, codify or separate from the context in which the work is performed. A seven-point scale (1 = Strongly Disagree to 7 = Strongly Agree) was used to assess knowledge and information involved in the work practices of a unit, based on employee's assessments of their daily tasks. The two tacitness factors from the refined instrument were labeled *observability* (α = 0.83) (Zander and Kogut, 1995; Winter, 1987) and *codifiability* (α = 0.89) based on the underlying questions that comprised each dimension (Nelson and Winter, 1982; Reed and DeFillippi, 1990). A composite tacitness measure was computed as the sum of the raw scores of these dimensions. Low scores on this measure indicate that a practice is difficult to observe or codify, suggesting highly tacit practices. The alpha coefficients, ICC(1), ICC(2) and $r^*_{wg(J)}$ for the tacitness scale used in this study were 0.82, 0.66, 0.90, and 0.75, respectively suggesting the use of the global tacit measure was appropriate.

3.6 Learnability

KIP learnability is the degree to which knowledge or skill needed for a work practice that requires accumulated information, characterized by contingencies, exceptions or inconsistencies, is causally ambiguous and highly complex. It was measured by a series of items with seven-point response sets (1 = Strongly Disagree to 7 = Strongly Agree). Items were designed to assess the volume- and path-dependent learning of essential information and knowledge (Kogut and Zander, 1992), interconnections or complexity among facts and conditions (Zander and Kogut, 1995), causal ambiguity of the knowledge and information and the depth of crucial learning processes.

Initial scales previously developed by Szulanski (1996) and Kogut and Zander (1992) were adapted for this study using the multi-phase approach described above. The two learnability factors that emerged were labeled *volume* ($\alpha = 0.78$) (Winter, 1987; Zander and Kogut, 1995) and *ambiguity* ($\alpha = 0.90$) (Szulanski, 1996) based on the items that comprised each dimension. A composite learnability variable was computed such that high scores represent a practice with knowledge characteristics that are *more difficult* to learn. The learnability construct was measured by summing raw scores of the volume and ambiguity measures. The alpha coefficient, ICC(1), ICC(2) and $r^*_{wg(J)}$ for the learnability scale used in this study were 0.89, 0.66, 0.89 and 0.77, respectively, suggesting the use of the global learnability construct was appropriate.

3.7 Knowledge-in-practice framework

To test the theorized framework proposed for KIP, we followed prior studies and used cluster analysis to examine the validity of the four KIP unit contexts (Hambrick, 1984). Classification is especially important to the study of business contexts that consist of many dimensions, such as the ones presented in the KIP framework in Figure 1. Classifications of this type help to organize cluttered conceptual landscapes (Hambrick, 1984). It is sometimes difficult to establish the appropriate number of clusters. We resolved this issue by following three steps:

1. Applied Ward's hierarchical technique using squared Euclidean distance and an agglomeration schedule to check for number of clusters.
2. Performed K-means non-hierarchical analysis as a validity check.
3. Validated the results using analysis of variance (ANOVA).

First, the decision on the number of clusters was guided by an agglomeration schedule using Ward's hierarchical clustering technique. The change in the agglomeration coefficient can be used to analyze how many clusters are sufficient. To accomplish this, a percentage change in the clustering coefficient was calculated as shown in Table II. A significant drop in the change coefficient between a four- and five-cluster solution suggests that a four-cluster solution is the appropriate number of clusters for the KIP context. In addition to Ward's hierarchical technique, a K-means non-hierarchical technique was also used and similar results were found.

To show the difference in the underlying knowledge between KIP contexts, means and standard deviations are reported by cluster group in Table III. *F*-tests at the 0.001 level support group differences. A Scheffé test to reflect differences among variables between each group provides further validation. Cluster interpretations are based on the values of each KIP variable measure within each cluster group. Learnability is the sum of the volume and ambiguity factors, while tacitness is the sum of the codifiability and observability variables.

Table II Agglomeration coefficients for KIP variables

No. of clusters	*Agglomeration coefficient*	*Differences in coefficient*	*Change in coefficient in next level %*
10	194.97	14.69	0.07
9	209.66	17.95	0.08
8	227.61	19.64	0.08
7	247.25	20.94	0.08
6	268.18	32.46	0.11
5	300.64	36.47	0.11
4	337.11	76.33	0.18
3	413.45	96.82	0.19
2	510.27	179.73	0.26
1	690.00		

Table III Knowledge-in-practice clusters means and standard deviations

	Enacted		*Apprenticed*		*Accumulated*		*Talent*		
Variables	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	F-*test*
Volume	1.92[a]	0.64	1.77	0.6	2.29[b]	0.79	3.74[b]	1.22	26.414*
Ambiguity	3.27	0.95	2.62	0.67	4.67[b]	1.16	5.21[b]	0.82	48.679*
Code	5.28	0.80	3.39[b]	0.81	5.96	0.67	3.13[b]	0.65	117.367*
Observe	3.87	0.82	2.9[b]	0.93	5.64	0.70	3.06[b]	0.90	103.735*
Learnability	20.76	4.80	17.58	3.11	27.82	4.66	35.79	6.63	75.43*
Tacit (explicit)	32.72	3.45	22.42[b]	4.22	40.75	3.95	21.70[b]	3.67	212.03*
N =	62		34		61		14		171

Notes: *F*-test:; *$p < 0.001$; Scheffe test $p < 0.05$; [b]different from two groups; [a]different from one group

Overall, the cluster solution provides support for the KIP framework and classification. For the enacted information KIP cluster, unit practices are learnable as signified by the low score on the learnability variable (20.76), and have a relatively low degree of tacitness as signified by the high score on the tacitness variable (32.72). As explained earlier, high scores on the tacitness variable indicate a high degree of codifiability and observability, meaning a high degree of explicitness or low degree or tacitness. For the apprenticed know-how KIP cluster, unit practices are characterized by a high degree of learnability signified by the low score on learnability variable (17.58) and a high degree of tacitness signified by the low score on the tacitness variable (22.42). The accumulated information KIP cluster units have a low degree of learnability signified by the high score on the learnability variable (27.82) and a low degree of tacitness signified by the high score on the tacitness variable (40.75). Finally, the talent and intuitive know-how KIP clusters are characterized by a high degree of tacitness signified by the low score on the tacitness variable (21.70) that are also difficult to learn signalled by the high score on the learnability variable (35.79). These measures are in line with and support the KIP framework presented in Figure 1.

4. Discussion

This study responds to the gap and ongoing debate in our understanding of knowledge in organizations by building a scale and a detailed process for measuring and analyzing knowledge in organizations. It specifically increases understanding about the types of knowledge underlying work practices.

Examining this topic required a number of important and logical steps, each of which made important contributions to KM research and practice. First, it was necessary to test and measure the KIP framework developed by McIver *et al.* (2013) that identifies knowledge characteristics which have critical implications for management. The results show that units can in fact be separated and distinguished using the scale developed here, resulting in a nuanced KBV of organizations. Having such a measure contributes to our understanding of the critical aspects of knowledge by supporting a KIP perspective that drives beyond the typical explicit–tacit dichotomy of knowledge and explores the underlying knowledge characteristics of work practices. It also supports theorizing in KM from a practice perspective by presenting empirical support for a framework focused on work activities and practices. It builds on previous efforts that examine the underlying characteristics of the work being done rather than viewing knowledge as a commodity that can be bundled and moved around or focusing only on the source of knowledge.

5. Conclusion

A growing body of research provides evidence that a key to achieving a competitive advantage is understanding how organizations manage what they know or what they need

to know. An important challenge is to understand how organizations effectively and efficiently measure and asses knowledge to manage it for value creation. A crucial first step is to understand the underlying knowledge characteristics of the work they do. The focus of this study was on answering two important questions: What are the underlying characteristics of KIP that are important to effectively manage a firm's knowledge resources? How do we measure these characteristics? This was accomplished by developing a reliable and valid scale for measuring the underlying knowledge characteristics of work and building a measurement method and support for the KIP framework. This provides a critical contribution for trying to unravel questions and theories about knowledge involved in work and knowledge management.

5.1 Findings

The new scale for measuring organizational knowledge involved in work based on the tacitness and learnability of work contexts developed here allows work units to be evaluated and assessed based on the underlying knowledge involved in different types of work. This measurement allows not only for a separation of work practices based on the underlying knowledge types but also a deeper and more granular understanding of knowledge and work in organizations. Specifically, the exploration of four different practice types – enacted information, apprenticed know-how, accumulated information and talent and intuitive know-how – based on the measured degree of tacitness involved and the measured degree of difficulty in learning the work activities will build on and complement current work and research on KM and extend future research in this area.

A second finding is our measurement of a previously unmeasured dimension: learnability. Although it is not the primary focus, the development of a measure of knowledge learnability is original and provides a new construct. This construct highlights the importance of two overlooked knowledge characteristics in organizations:

1. KIP with a high degree of tacitness that is easy to learn; and
2. KIP with a low degree of tacitness that remains difficult to learn.

This distinction addresses an implicit, but inaccurate, assumption that all tacit knowledge is difficult to learn. For this reason, it is a significant empirical contribution of this study

5.2 Limitations

Despite the important contributions from this study, several limitations remain. First, the study was conducted in the health-care industry to control for between-industry differences. Although the choice to use health-care facilities provided a good fit for this study, the results may not generalize to other industries. However, while the extent to which our findings may be extended to other industries remains to be explored, we believe the scale will be appropriate for a variety of other contexts. The single industry focus was necessary because of the exploratory nature of this study. Nonetheless, it would be useful to follow-up with a mixed-methods analysis that could provide a more granular approach and deeper analysis for understanding organizational work and how it is performed. This single-industry focus was also necessary for aggregation purposes and provided the opportunity to focus on phenomena that are often included in an umbrella term or broader knowledge construct. It is possible that a more useful question is not the generalizability of findings, but the need for research to follow a more detailed method of observing and identifying the appropriate level of analysis to conduct surveys and aggregate results.

Another limitation emerges from our use of the unit as the level of analysis. Because organizations use this label to describe work configurations that vary greatly within and across organizations in the extent to which workers actually function as a unit, there is

a potential for mis-specifying the work boundaries despite careful review by individuals working within each organization. This is of course another limitation in most research and analysis and also points to the need for a finer grained and mixed-methods approach to research.

Finally, another limitation is the use of a cross-sectional research design. A snapshot of a single point in time may not accurately assess the underlying knowledge involved in work contexts. More importantly, with a cross-sectional design, we are unable to understand how work may change or transform over time with the introduction of new technology and processes. It is a limitation of this study, but also provides an opportunity for future work to grow our understanding of work in organizations.

5.3 Theoretical implications

To the best of our knowledge, this study is the first study to empirically test the KIP framework. Knowledge has been measured in a number of ways in organizations. However, few researchers have directly measured the underlying knowledge characteristics of work. This study is significant because it builds on the theoretical foundation of the KIP framework to understand the types of knowledge involved in work in organizations.

Compared to existing literature, this study looks deeper into the type of work activities being performed from a KBV of organizations, and offers more specific details by dividing and measuring KIP along the two continuums of learnability and tacitness. The results strongly support that KIP can provide a new method for understanding knowledge in organizations. Few studies have empirically broken down work from a KBV. The findings also suggest that this granular approach may help to understand the complex underpinnings of work in a knowledge-based economy, which cannot be viewed from a single lens or framework. Therefore, the KIP framework provides an alternative theoretical approach for research aimed at acquiring an in-depth understanding of the different types of knowledge underlying work in organizations, as opposed to singular view focusing on all work and contexts.

5.4 Practical implications

In addition to the impact on research, there are several general and specific managerial implications for organizations and managers. For example, a general impact would be looking at training and development initiatives from a knowledge perspective, which will allow organizations to target and focus learning and development activities by the type of knowledge they involve. The measurement model developed here can provide a general guideline for understanding work at more of a granular level. An example of a more specific and direct impact would be to look at job design and job roles within organizations from a KIP perspective and then examine how certain roles are designed for scale and quality purposes. These two examples of practical implications are important as many KM initiatives when applied together are not complementary and can be counterproductive, or even harm performance if applied in the wrong work setting or wrong combination (Argote *et al.*, 2003). In sum, a KIP framework can provide a general guideline and direction in these situations and help steer the design and implementation of KM strategies and the adoption of individual KM initiatives to enable performance in different roles.

5.5 Future research

The framework and findings presented here not only have practical and theoretical significance but also help direct scholars working on knowledge management, knowledge work, knowledge workers and KBV issues to develop their research in promising new directions.

Efforts to understand the dynamics of knowledge within unit-level practice contexts present an exciting extension of this study. We assumed that unit-level practice characteristics are relatively stable. However, both longitudinal empirical research designs and further theorizing are needed to develop an understanding of whether the underlying knowledge characteristics of unit-level practices change, and if they change, how they change and why they change. An interesting question unearthed by this study is whether firms can implement KM initiatives to alter the underlying knowledge characteristics of work, or if they might be able to maximize performance by focusing investments in KM based on the underlying type of KIP of a unit. Similarly, it would be useful for future research to understand whether other forces, such as environmental shocks or technological innovations, alter the learnability or tacitness of unit practices. Perhaps, the ability to match KM initiatives with changing knowledge types might reflect a dynamic capability (Helfat and Peteraf, 2003). To understand these phenomena and then be able to manage them, measurement is the key first step.

References

Argote, L., McEvily, B. and Reagans, R. (2003), "Managing knowledge in organizations: an integrative framework and review of emerging themes", *Management Science*, Vol. 49, pp. 571-582.

Bliese, P.D. (2000), "Within-group agreement, non-independence, and reliability: implications for data aggregation and analysis", in Klein, K.J. and Koslowski, S.W.J. (Eds), *Multilevel Theory, Research, and Methods in Organizations: Foundations, Extensions, and New Directions*, Jossey-Bass, San Francisco, CA, pp. 349-381.

Brown, J.S. and Duguid, P. (2001), "Knowledge and organization: a social perspective", *Organization Science*, Vol. 12 No. 2, pp. 198-213.

Browne, M.W., Cudeck, R. and Bollen, K.A. (1993), "Alternative ways of assessing model fit", *Sage Focus Editions*, Vol. 154, p. 136.

Carmines, E.G. and McIver, J.P. (1981), "Analyzing models with unobserved variables: analysis of covariance structures", *Social Measurement: Current Issues*, pp. 65-115.

Cascio, W. and Boudreau, J. (2010), *Investing in People: Financial Impact of Human Resource Initiatives*, Ft Press.

Chen, C.-J. and Huang, J.-W. (2009), "Strategic human resource practices and innovation performance—the mediating role of knowledge management capacity", *Journal of Business Research*, Vol. 62, pp. 104-114.

Cook, S.D.N. and Brown, J.S. (1999), "Bridging epistemologies: the generative dance between organizational knowledge and organizational knowing", *Organization Science*, Vol. 10 No. 4, pp. 381-400.

Dierickx, I. and Cool, K. (1989), "Asset stock accumulation and sustainability of competitive advantage", *Management Science*, Vol. 35, pp. 1504-1511.

Duguid, P. (2005), "'The art of knowing': social and tacit dimensions of knowledge and the limits of community of practice", *The Information Society*, Vol. 21 No. 2, pp. 109-118.

George, J.M. (1990), "Personality, affect, and behavior in groups", *Journal of Applied Psychology*, Vol. 75 No. 2, pp. 107-116.

Glick, W.H. (1985), "Conceptualizing and measuring organizational and psychological climate: pitfalls in multilevel research", *Academy of Management Review*, Vol. 10 No. 3, pp. 601-616.

Grant, R.M. (1996), "Towards a knowledge-based theory of the firm", *Strategic Management Journal*, Vol. 17 No. 1, pp. 109-122.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1995), *Multivariate Data Analysis with Readings*, Prentice-Hall International, Englewood Chiffs, NJ.

Hambrick, D.C. (1984), "Taxonomic approaches to studying strategy: some conceptual and methodological issues", *Journal of Management*, Vol. 10 No. 1, pp. 27-41.

Helfat, C.E. and Peteraf, M.A. (2003), "The dynamic resource based view: capability lifecycles", *Strategic Management Journal*, Vol. 24 No. 10, pp. 997-1010.

Hult, G.T.M., Ketchen, D.J. and Slater, S.F. (2004), "Information processing, knowledge development, and strategic supply chain performance", *Academy of Management Journal*, Vol. 47, pp. 241-253.

Kogut, B. and Zander, U. (1992), "Knowledge of the firm, combinative capabilities, and the replication of technology", *Organization Science*, Vol. 3 No. 3, pp. 383-397.

Kogut, B. and Zander, U. (1995), "Knowledge and the speed of the transfer and imitation of organizational capabilities: an empirical test", *Organization Science*, Vol. 6 No. 1, pp. 76-92.

Kozlowski, S.W.J. and Klein, K.J. (2000), "A multilevel approach to theory and research in organizations: contextual, temporal, and emergent processes", in Klein, K.J. and Kozlowski, S.W.J. (Eds), *Multilevel Theory, Research, and Methods in Organizations: Foundations, Extensions, and New Directions*, Jossey-Bass, San Francisco, CA, pp. 3-90.

Lane, P.J., Salk, J.E. and Lyles, M.A. (2001), "Absorptive capacity, learning and performance in international joint ventures", *Strategic Management Journal*, Vol. 22, pp. 1139-1161.

Lave, J. and Wenger, E. (1991), *Situated Learning: Legitimate Peripheral Participation*, Cambridge University Press, New York, NY.

Lindell, M.K. and Brandt, C.J. (1999), "Assessing interrater agreement on the job relevance of a test: a comparison of the CVI, T, rWG(*J*) and r*WG(*J*) indexes", *Journal of Applied Psychology*, Vol. 84 No. 4, pp. 640-647.

Lindell, M.K., Brandt, C.J. and Whitney, D.J. (1999), "A revised index of interrater agreement for multi-item ratings of a single target", *Applied Psychology Measurement*, Vol. 23 No. 2, pp. 127-135.

McIver, D. and Lengnick-Hall, C.A. (2011), "Knowledge management processes and unit performance: a contingency perspective", *Academy of Management Best Paper Proceedings*.

McIver, D., Lengnick-Hall, C.A., Lengnick-Hall, M.L. and Ramachandran, I. (2012), "Integrating knowledge and knowing: a framework for understanding knowledge-in-practice", *Human Resource Management Review*, Vol. 22, pp. 86-99.

McIver, D., Lengnick-Hall, C.A., Lengnick-Hall, M.L. and Ramachandran, I. (2013), "Understanding work and knowledge management from a knowledge-in-practice perspective", *Academy of Management Review*, Vol. 38 No. 4, pp. 597-620.

McIver, D., Ramachandran, I., Lengnick-Hall, C.A. and Lengnick-Hall, M.L. (2010), "Rethinking the nature of knowledge management research: implications for strategic human resource management", *Academy of Management Best Paper Proceedings*.

Marsh, H.W., Barnes, J. and Hocevar, D. (1985), "Self-other agreement on multidimensional self-concept ratings: factor analysis and multitrait-multimethod analysis", *Journal of Personality and Social Psychology*, Vol. 49, p. 1360.

Nelson, R.R. and Winter, S.G. (1982), *An Evolutionary Theory of Economic Change*, Belknap Press, Cambridge, MA.

Nonaka, I. (1994), "A dynamic theory of organizational knowledge creation", *Organization Science*, Vol. 5 No. 1, pp. 14-37.

Oguz, F. and Elif Sengün, A. (2011), "Mystery of the unknown: revisiting tacit knowledge in the organizational literature", *Journal of Knowledge Management*, Vol. 15 No. 3, pp. 445-461.

Pitt, M. and MacVaugh, J. (2008), "Knowledge management for new product development", *Journal of Knowledge Management*, Vol. 12, pp. 101-116.

Ployhart, R.E. and Moliterno, T.P. (2011), "Emergence of the human capital resource: a multilevel model", *Academy of Management Review*, Vol. 36 No. 1, pp. 127-150.

Polanyi, M. (1966), *The Tacit Dimension*, Routledge & Kegan Paul, London.

Ragab, M.A. and Arisha, A. (2013), "Knowledge management and measurement: a critical review", *Journal of Knowledge Management*, Vol. 17 No. 6, pp. 873-901.

Reed, R. and DeFillippi, R.J. (1990), "Causal ambiguity, barriers to imitation, and sustainable competitive advantage", *Academy of Management Review*, Vol. 34, pp. 382-400.

Rigdon, E.E. (1996), "CFI versus RMSEA: a comparison of two fit indexes for structural equation modeling", *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 3, pp. 369-379.

Salk, J.E. and Simonin, B. (2002), "Beyond alliances: towards a meta-theory of collaborative learning", in Easterby-Smith, M. and Lyles, M.A. (Eds), *The Blackwell Handbook of Organizational Learning and Knowledge Management*, Malden, MA, pp. 253-277.

Simonin, B.L. (2004), "An empirical investigation of the process of knowledge transfer in international strategic alliances", *Journal of International Business Studies*, Vol. 35 No. 5, pp. 407-427.

Snowden, D. (2002), "Complex acts of knowing: paradox and descriptive self-awareness", *Journal of Knowledge Management*, Vol. 6 No. 2, pp. 100-111.

Szulanski, G. (1996), "Exploring internal stickiness: impediments to the transfer of best practice with the firm", *Strategic Management Journal*, Vol. 17, pp. 27-43.

Wiig, K.M. and Jooste, A. (2003), "Exploiting knowledge for productivity gains", in Holsapple, C.W. (Ed.), *Handbook on Knowledge Management, Volume 2: Knowledge Directions*, Springer-Verlag, Berlin, pp. 289-308.

Winter, S.G. (1987), "Knowledge and competence as strategic assets", in Teece, D.J. (Ed.), *The Competitive Challenge – Strategies for Industrial Innovation and Renewal*, Ballinger, Cambridge, MA, pp. 157-184.

Zander, U. and Kogut, B. (1995), "Knowledge and the speed of the transfer and imitation of organizational capabilities: an empirical test", *Organization Science*, Vol. 6, pp. 76-92.

Appendix

Table AI Factor loadings and aggregation measures for variables

Scale items	*Factor loadings*	*Cronbach's Alpha*	$r^*_{wg(j)}$	*ICC (1)*	*ICC (2)*
Codifiiability		0.89	0.76	0.66	0.90
The work we do in our unit could be described in a manual	0.82				
It is possible to list all of the skills needed to do the work in our unit	0.80				
We could write down all the important parts of the work done in our unit	0.90				
We could list all the materials and resources we need to do the work in our unit	0.80				
Observability		0.83	0.75	0.67	0.90
The work we do in our unit can be understood by reading a description of the activities	0.67				
New people in our unit can learn how to do our work by talking to employees	0.93				
New people in our unit can learn how to do our work by taking classes	0.78				
Volume		0.78	0.86	0.65	0.91
A lot of training is needed to perform the work we do in our unit	0.75				
Specific skills are needed to perform the work we do in our unit	0.71				
Experience is needed to perform the work we do in our unit	0.69				
It takes a lot of time to learn how to perform the work we do in our unit	0.65				
Ambiguity		0.90	0.73	0.63	0.89
In our unit we always know what the results will be before performing our work (reverse coded)	0.81				
We could list all the steps that would let someone learn how to do the work we do in our unit (reverse coded)	0.75				
There are clear steps for how the work in our unit needs to be done (reverse coded)	0.97				
The work we do in our unit is performed the same way every time we do it (reverse coded)	0.82				

About the authors

Dr Derrick McIver, Assistant Professor of management at Western Michigan University, teaches strategic management, leadership and strategic human resource management. His primary research interests include knowledge management and workforce analytics. Derrick McIver is the corresponding author and can be contacted at: derrick.mciver@wmich.edu

Dr Xiaodan "Abby" Wang, Assistant Professor of management at Western Michigan University, teaches strategic management and multinational management. Her primary research interests include knowledge management, corporate social responsibility and firm performance, internationalization of venture capital firms, and entrepreneurship in emerging and transitional economies. Her research has been published in *Strategic Entrepreneurship*, *American Journal of Business* and *Journal of Teaching in International Business*.