Knowledge and Process Management
Volume 16 Number 4 pp 147–161 (2009)
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/kpm.331

■ *Research Article*

The Concept of Knowledge in KM: A Knowledge Domain Process Model Applied to Inter-Professional Care

Michael Max Evans[1,2*,†,‡] and Joel Alleyne[1,2,§,¶]

[1]*Faculty of Information, University of Toronto, Canada*
[2]*Knowledge Media Design Institute, University of Toronto, Canada*

Grounded in a social construction view of knowledge and based on the work of Haridimos Tsoukas and Max Boisot, this paper attempts to extend Colin Reilly's knowledge domain model using a process modeling approach. The objective of this paper is to construct a more comprehensive meta-understanding of knowledge domains that considers the influence of organizational context, of a community or group (social construction of knowledge), the presence of events and knowledge artifacts, temporal cycles, and individual knowledge processes.

The authors begin by synthesizing the existing literature review to construct the proposed Knowledge Domain Process (KDP) model. Following the construction of the model, the authors develop and use a composite case (from a number of cases experienced by one of the authors as a practitioner) to illustrate the application of the model. The proposed model is then applied to an Inter-Professional Care (IPC) setting within health care, to illustrate how knowledge is constructed, exchanged, and used across numerous health care communities, in an effort to improve coordination and care.

The KDP model attempts to provide researchers and practitioners with a more structured, detailed, and analytical way of looking at the processes involved in knowledge construction and dissemination. This model is viewed as a work-in-progress and is still under development. Use by others is encouraged and will help validate or refute the model in part or in whole.

INTRODUCTION

This paper builds on the work of organizational and social construction theorists to present a multi-dimensional abstraction of the environment and processes involved in the construction and dissemination of knowledge (knowledge domain). The aim is to construct a comprehensive meta-understanding of knowledge domains, considering the influence of organizational context, community or group environment (social construction of knowledge), events and knowledge artifacts, temporal cycles, and individual knowledge processes. The proposed model does not attempt to create a complete epistemological or ontological view of all knowledge processes.

The field of Inter-Professional Care (IPC) is used to illustrate the application of the proposed Knowledge Domain Process (KDP) model. IPC was chosen

*Correspondence to: M. Max Evans, Faculty of Information, University of Toronto, Canada. E-mail: max.evans@utoronto.ca
†Doctoral Candidate.
‡Doctoral Member.
§Doctoral Student.
¶Practitioner-in-Residence.

because few published papers addressing informatics issues or knowledge management specifically exist in this area. The authors hope that the model can be used to illuminate knowledge processes in IPC, leading to better coordination across disciplines and improved outcomes for patients.

RATIONALE AND PURPOSE FOR THE KNOWLEDGE DOMAIN PROCESS (KDP) MODEL

The KDP model attempts to bridge two views of knowledge, one highly messy and one highly analytical. The former argues that knowledge processes are highly complex, more ecological than mechanistic, and can never be completely or even comprehensively modeled (Choo *et al*., 2000; Davenport, 1997). The latter asserts that knowledge can be modeled and addresses the analysis and management of knowledge processes by applying a systems viewpoint (treating knowledge flow as data or information). This paper does not attempt to displace or disprove either perspective, rather to embrace and bridge both.

No known model provides a comprehensive view of the elements or components and processes involved in the knowledge domain. Though interesting and informative, existing models of the knowledge domain attempt to model only parts of the environment (e.g., Nonaka and Takeuchi's (1995) SECI Model; Boisot's (1998) Data, Information, Knowledge; and Reilly's (2008) Relational Knowledge Domain Model). The KDP model is built using a careful analysis of the related literature on knowledge in an attempt to build a more comprehensive understanding.

The authors recognize that knowledge processes are messy and caution the user of this framework that the KDP model, like all models, is an abstraction aimed at making complex systems more easily understood. While the model presents knowledge processes in a structured and simplified form, the nature and structure of the processes themselves may be open to debate. The proposed model is intended to provide an analytical way of looking at the processes involved in knowledge construction and dissemination (even if some contributing elements result in the addition of complexity). In an applied or practical setting, the model can be used to:

- examine and understand an organization's or group's knowledge environment;
- design knowledge intensive collaborative work environments;
- map and describe key knowledge activities;
- design compatible work practices and information systems; and,
- develop hiring criteria that promote and support effective norms and knowledge practices.

RELEVANT THEORETICAL PERSPECTIVES

Data, information, and knowledge

Some authors (Alavi and Leidner, 2001; Earl, 2001) use the terms ''information'' and ''knowledge'' interchangeably, arguing that there is little practical merit to making the distinction. This approach usually arises from a systems or computer science background, and though it may provide a foundation that facilitates scientific inquiry (quantifiable and measurable data), it does not reflect significant distinctions that can be made between data, information, and knowledge. This point has been made by many organizational and knowledge management (KM) theorists (Boisot 1998, 2002; Choo 1998; Davenport and Prusak, 1998; Huber, 1991; Leonard and Sensiper, 2002; Nonaka, 2002; Nonaka and Takeuchi, 1995; Thompson and Walsham, 2004; Tsoukas, 2005a).

Data, information, and knowledge are three independent concepts that may be characterized as elements along a continuum (Boisot, 1998, 2002; Leonard and Sensiper, 2002; Nonaka, 2002; Nonaka and Takeuchi, 1995; Tsoukas, 2005a). Boisot (1998) explains the relationship between these concepts: ''knowledge builds on information that is extracted from data.'' (p.12). Leonard and Sensiper (2002, p.485) claim that, ''knowledge is a subset of information''. Nonaka and Takeuchi (1995) view data, information, and knowledge as active rearrangements of each other: ''Information is a flow of messages [or meanings], while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder'' (pp. 58– 59). Nonaka (2002) claims that, ''information is a necessary medium or material for initiating and formalizing knowledge'' (p.439). Huber (1991) and Boisot (2002) imply a similar intellectual framework by referring to knowledge as interpreted information.

> *. . .it is never knowledge as such that flows between agents, but rather data from which information has to be extracted and internalized. Only when information has been successfully internalized and forms part of an agent's repertoire of expectations and behaviors can it properly be called knowledge*. (Boisot, 2002, p.72)

Tsoukas (2005a) specifically locates the meaning of the terms data, information, and knowledge along a continuum, ''depending on the extent to

which they reflect human involvement with, and processing of, the reality at hand. . .put simply, data require[s] minimal human judgment, knowledge maximum judgment'' (p.120). Thus, under this interpretation, knowledge may be clearly distinguished from data and information. This is the position that will be adopted in this paper.

Defining data and information

The term *data* means something that is a given or accepted at face value. One may think of data as inputs and outputs from a system (numbers, characters, images, etc.). According to Boisot, data is ''a discrimination between physical states'' (1998, p.12) that is ''located in the world'' (2002, p.67) and ''can be characterized as a property of things'' (1998, p.12). It is not necessary for data to convey information to agents, and two separate agents may interpret the same data as two distinct pieces of information.

Data is often considered as being captured, processed, stored or disseminated. It is data, as opposed to knowledge, that flows between agents and systems. It is the responsibility of the agent to spot an opportunity or threat based on patterns within that data in combination with that agent's past experience. Extracting the patterns within the data is a creative task of the agent and can be unique for each agent (with one agent perceiving a pattern while another fails to) (Boisot, 2002).

Information may be thought of as a ''flow of messages'' (Nonaka, 2002, p.438) that establishes a relationship between things and agents (Boisot, 1998). This relationship is best described in Boisot's (1998) diagram (Figure 1). Boisot argues that data is inherent to objects and events (things). Agents use perceptual and conceptual filters to create a subset of these data from the objects and events. Once this subset of data (interpretation) is created, an established relationship between the agent and object is formed. This established relationship is called *information*.

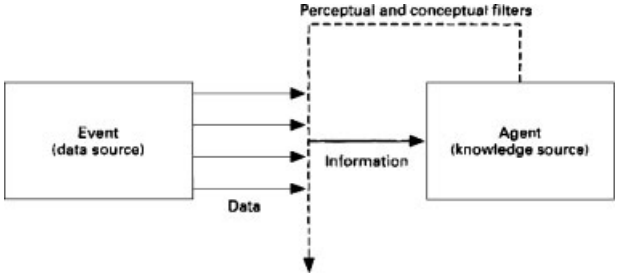

Figure 1 Boisot's data, information, and knowledge relationship (1998, p.12)

Defining knowledge

Using an approach based on activity theory, *knowledge* is defined as: *The potential of an activity, situated within a socially constructed domain, bounded by the developmental capacity of an individual*. This definition is not presented in precisely this form by any other author though its components encompass the core ideas of many noted philosophers and organizational theorists.[1]

This paper does not attempt to resolve a two-thousand year old debate on the definition of knowledge, rather provide a definition suitable and consistent with an extensive body of research, that can be applied to managerial and organizational studies. Each of the five components of the definition (below) was carefully considered and is based on peer-reviewed research.

(1) Knowledge is created, interpreted, disseminated, and displayed through activity.
(2) Knowledge is situated within a particular domain.
(3) Knowledge is socially constructed and interpreted.
(4) Knowledge is personal and bounded by developmental capacity.
(5) There is a potential to knowledge (i.e., domain, social construction, and developmental capacity are partial determinants of the potential value of knowledge).

Knowledge management (KM)

KM is achieved through an organization's management of its knowledge strategies, knowledge processes, and the domain in which knowledge exists and thrives. KM practices lead to the optimal use of an organization's knowledge assets.[2]

Dalkir (2005, p.337) cataloged well over one hundred definitions of KM before she presented the following definition:

> *The deliberate and systematic coordination of an organization's people, technology, processes, and organizational structure in order to add value through reuse and innovation. This value is achieved through the feeding of valuable lessons learned and best practices into corporate memory in order to foster continued organizational learning*.

[1]For example Polanyi (1962, 1975); Spender (1996a,b); Nonaka and Takeuchi (1995); Nonaka (2002); Choo (1998); Tsoukas (2005a,b); Leont'ev (1978); Wittgenstein (1953); Vygotsky (1978); Boisot (1998, 2002)
[2]Knowledge Assets: human capital; structural capital; and relationship/social capital (Edvinsson and Malone, 1997)

DOI: 10.1002/kpm

UNDERSTANDING THE KDP MODEL

The KDP model (Figure 2) is described below in six layered but distinct components: *Events, Knowledge Artifacts, Individual Knowledge Processes, Group Influence, Organizational Context, and Time*.

Events and knowledge artifacts (as data sources)

An event is defined as an experience registered, perceived, and personalized by an individual. This experience is structured according to individual values and is used as data in building a personal understanding of the situation. An event may trigger the individual's attention or action and be a starting point for the proposed KDP model (Figure 3).

Building on Reilly (2008), this paper defines knowledge artifacts as explicit meaningful representations of data, such as organizational stories, theories, and ontologies. Knowledge artifacts can take the form of methodologies, best practices, policies, or procedures. Some examples of knowledge artifacts include employee or patient records, knowledge portals, content management systems, discussion threads, books, manuals, and prototypes. Physical data is situated or recorded in knowledge artifacts, which are constantly evolving (i.e., being added, edited, or deleted).

Events are less structured than knowledge artifacts yet they contain important tacit cues vital to building the individual and group understanding not present in knowledge artifacts. Since these tacit elements may not be codified, an event can be a source for unique data not found in knowledge artifacts. Knowledge artifacts can also be representations of events but cannot and do not represent the event in its entirety.

Individual knowledge processes

Knowledge has an active, subjective nature, which is created by the individual (Nonaka, 2002). ''All knowing is personal knowing'' (Polanyi and Prosch, 1975, p.44) and ''all knowledge is personal knowledge'' (Tsoukas 2005a, p.126). The second component of the KDP model focuses on the individuals' tasks and processes, which are influenced by personal values and attitudes.

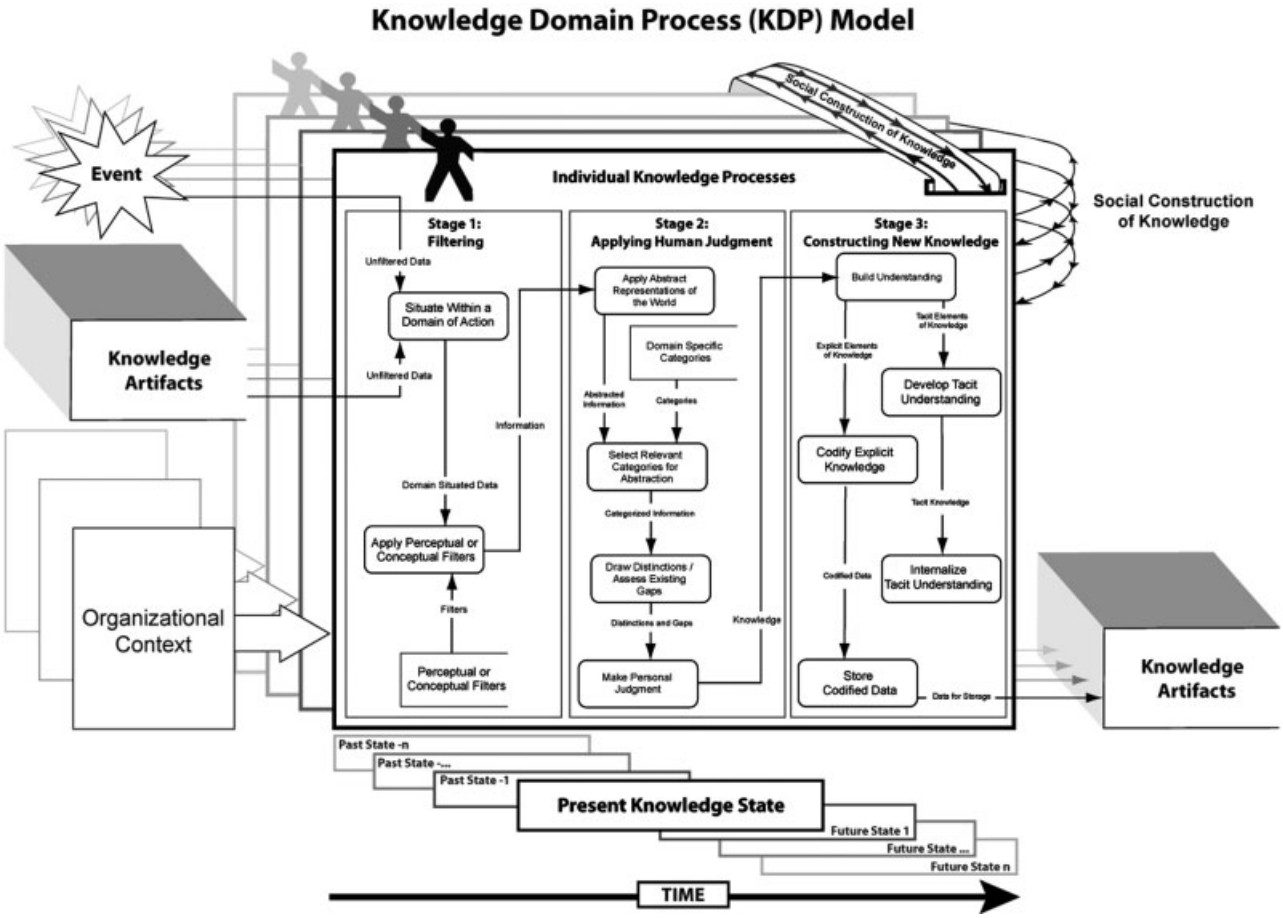

Figure 2 Knowledge Domain Process (KDP) model

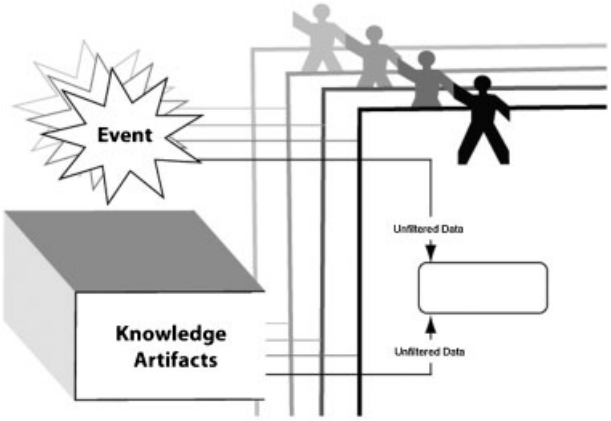

Figure 3 Events and knowledge artifacts

This portion of the model is subdivided into three distinct stages: (1) Filtering, (2) Applying Human Judgment, and (3) Constructing New Knowledge.

Stage 1: Filtering (Figure 4). The first process within the *filtering* stage involves an individual situating newly extracted explicit data into their own unique *domain of action* (Tsoukas, 2005a). Reilly (2008) alludes to this process as interpreting artifacts through a ''prism of a genre'' (p.708). It is useful to consider the concept of domain as three separate but interrelated dimensions: form, content, and context.

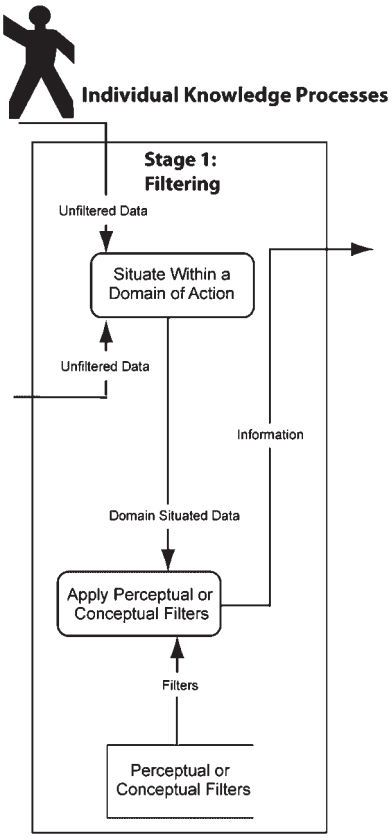

Figure 4 Filtering

An individual's knowledge state will be influenced by a unique, personal construction, and representation of these three dimensions.

The *form* of a domain is the structure of information and the channel through which it is being communicated. Form consists of physical objects, such as textbooks, maps, prototypes, or architectural models. Form also has a more conceptual meaning; such is the example when discussing language, metaphor, analogies, or mental models (Blackler, 2002; Toulmin, 1999; Tsoukas, 2005a; Vygotsky 1978). These representations of form are commonly referred to as *instruments* (Vygotsky) or *cultural tools* (Tsoukas).

Content refers to the specific data or meanings derived from a particular domain or to data represented in the form. Toulmin (1999) argues that, ''language has a definite meaning only when it is related to a given constellation of practical activities. . .we understand the meaning of the word strike only if we are familiar with the game of baseball'' (p.59). Similarly, algebraic concepts (content) are learned or understood by students through the use of algebraic equations, metaphors, and analogies (form).

The final dimension of domain is *context*. Context refers to how other domains influence and support meaning and understanding in the domain in question. Context helps determine interpretation. Thompson and Walsham (2004) define context as ''the relationally situated ingredients through which knowing occurs'' (p.735). Form may remain constant throughout various contexts, yet the content or meaning often changes between contexts. Toulmin (1999) explains that ''Playing baseball. . . provides the background against which the word strike has this meaning. The shared intelligibility of any utterance requires it to have a standard place in a specific practical context'' (p.60).

The appropriate interpretation of a form depends on its context as well as the nature of the community within that context (Duguid, 2005; Leonard and Sensiper, 2002). According to Nonaka (1994), ''what makes sense in one context, can change or even lose its meaning when communicated to people in a different context'' (p.30). To effectively interact with the domain in question, Duguid (2005) suggests that an agent must learn to decode from the perspective of that domain and community. This idea is consistent with Wittgenstein (1953), who argues that meaning and practical implication of terms depend on their use and on the framework in which they exist. Wittgenstein (1953), Spender (1996a), and Thompson and Walsham (2004) would argue that the meaning of all knowledge is tied up within the context of its development. This also supports Lave

DOI: 10.1002/kpm

(1993) and Blackler's (2002) argument that knowledge may not be divorced from context and transmitted as simply abstract data (form).

According to Boisot (2002), ''no two agents possess identical mental schemas, they will therefore assimilate and accommodate new knowledge in different ways...external data that different agents receive may be identical, what actually gets absorbed by each as knowledge will differ'' (p.73). Since all agents will have different contexts, no two agents can share exactly the same meaning. To truly interpret meaning within a domain, an agent must understand that domain's interrelated contexts. Being able to act prudently and correctly within any particular domain is correctly understanding the contexts influencing that domain; Aristotle (1955) called this ''*phronesis*'' (''practical wisdom'') (Tsoukas, 2005a; Van De Ven and Johnson, 2006; Wenger, 1998).

The second process in the *filtering* stage involves applying unique perceptual and conceptual filters to create interpreted subsets of data (Boisot, 1998). These perceptually and conceptually filtered subsets of data, which are already situated within the individual's domain become *information* for that individual.

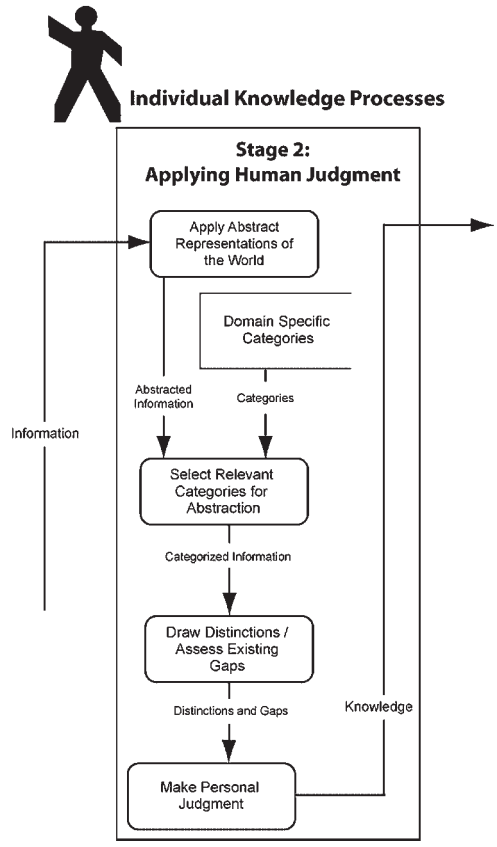

Figure 5 Applying human judgment

Stage 2: Applying human judgment (Figure 5). According to Tsoukas (2005b), personal judgment is involved when ''applying abstract representations of the world'' (p.144) and making assessments of the existing gaps within these representations. Tsoukas (2005a) describes personal judgment as being associated with the prefix ''re-'' (e.g., re-order, re-arrange, and re-design) and explains that judgment involves the personal ability to draw distinctions or divide the world into ''this'' and ''that''. Spender (1996b) describes the drawing of a distinction (categorization) as an ''exercising of reason''. Bell (1973) and Boisot (1998) believe this to be guided by a set of probability distributions or organized statements of facts and ideas.

Being able to select the relevant categories for abstraction requires prior knowledge of the domain in question (Boisot, 2002). A differential equation cannot alone predict an unknown function of its variables; it is the application and use of differential equations in engineering, physics, and economics that allows individuals to make reasoned judgments and create new knowledge. All judgments, ideas and probability distributions within one domain will inevitably encounter messiness and complexity once introduced into another domain. According to Tsoukas (2005b), exercising judgment involves ''the ability of an individual to draw distinctions and the location of the individual within a collectively generated and sustained domain of action'' (p.120). A medical student must be part of the medical domain and be able to draw distinctions and make judgments within that domain to be successful.

Stage 3: Constructing new knowledge (Figure 6). Combined personal judgments allow the individual to build an understanding of the problem area, which constitutes new knowledge for the individual and possibly for the community. This new knowledge will most likely have both tacit and explicit elements. If the new knowledge contains tacit elements, then tacit knowing must be developed within the individual. Tacit knowing occurs through a process of unconscious trial and error, a feeling-out process in which the agent is increasingly successful over time without, in a theoretical sense, specifically knowing how (Polanyi, 1962). For Nonaka (2002), tacit knowing is a continuous activity developed through the communication of individuals, in an effort to create mutual understanding. For Choo (2000), tacit knowing is achieved through ''extended periods of experiencing and doing a task, during which the individual develops a feel for and a capacity to make intuitive judgments about the successful execution of the activity'' (p.395).

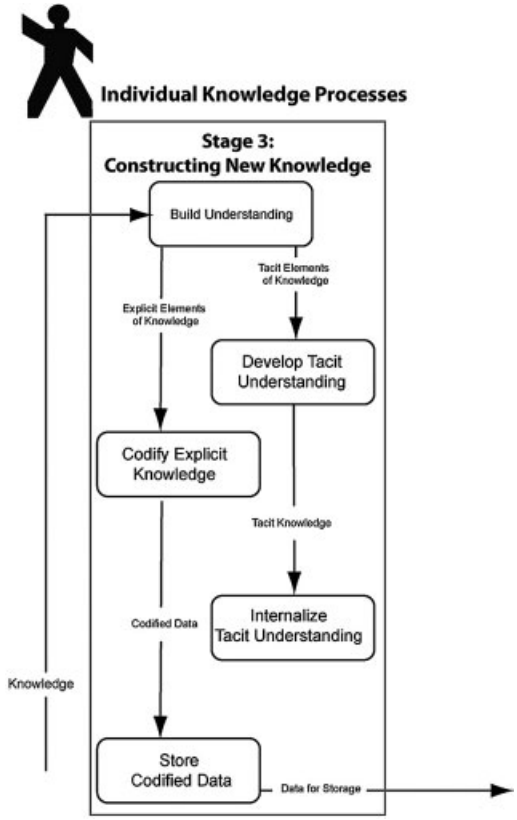

Figure 6 Constructing new knowledge

Individuals may successfully internalize the newly developed tacit knowledge but may not have the ability to explain how this was done. Tsoukas (2005b), like Polanyi, argues that tacit skills retain opacity and un-specificity in terms of their particulars. The practitioner is able to perform the skill without having theoretical knowledge of the particulars involved. For Tsoukas (2005b, p.158),

> *Tacit knowledge consists of a set of particulars of which we are subsidiarily aware as we focus on something else. Tacit knowing is vectorial: we know the particulars by relying on our awareness of them for attending to something else.*

Since the tacit elements of the individual's new understanding cannot exist independently from the individual, they may never be stored in a knowledge artifact. Conversely, individuals may take the explicit elements of this new understanding and be able to codify[3] and store them.

Explicit knowledge is understood to exist independently from the human agent who is the knower (De Long and Fahey, 2000). Choo (1998, 2000) divides explicit knowledge into *object-based* or *rule-based*. Object-based explicit knowledge is embedded into artifacts and is usually represented using a string of symbols or is embodied in the entity itself (Choo, 2000). Some examples given by Choo (2000) include: products, patents, computer databases, technical drawings, tools, prototypes, photographs, voice recordings, and films (p.396). Explicit knowledge is rule-based when it takes the form of rules, routines, or operating procedures (Choo, 2000). Other examples of explicit knowledge include: documents, pictures, stories, diagrams, and narratives (Seely *et al*., 2000 p.76).

Group influence (social construction)

Vygotsky (1978) and his activity theory colleagues argue that human consciousness is shaped by social experiences and mediated by culturally established tools. Marx (1932; Third Manuscript) argues that, ''the eye has become a *human* eye, just as its *object* has become a social, human object—an object made by man for man''. Leont'ev (1978, p.18) elaborates:

> *Isolated activity cannot be understood apart from social ties... Entering into contact with each other, people formulate a language that serves to represent the objects, the means, and the very process of work itself. [W]ords, the language signs, are not simply replacements for things, their conditional substitutes. Behind philological meanings is hidden social practice, activity transformed, and crystallized in them; only in the process of this activity is objective reality revealed to man.*

This premise of socially constructed consciousness is foundational to work in activity theory and is so influential that it is found in activity theory-based definitions of consciousness itself:

> *Man is born into the world of objects created by previous generations, and is formed as such only in the process of learning how to use them to a definite end. The mode of his relation to reality is not determined directly by his bodily organisation (as in the case with animals), but by the habits of practical activity acquired solely through communication with other people.*[4] (Tolman, 1988 p.16)

Many theorists have turned toward social construction and activity theory to understand and define knowledge creation and dissemination. Gherardi (2001) argues that, ''learning and knowing

[3]According to Boisot (2002, p.68) codification, ''refines the categories that the agent invokes or creates so that it can use them efficiently and in discriminating ways. The fewer data an agent has to process to distinguish between categories, the more codified the categories that it has to draw upon.''

[4]Extract taken from Tolman's (1988) *The basic vocabulary of Activity Theory*. Original text appeared in Frolov's (1984 pp.81–82) *Dictionary of philosophy*.

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are mediated by social relations...knowledge resides in social relations... [And] knowing is part of a surrendering to a social habit'' (p.133). Nonaka (1994) claims that knowing is something that emerges through continuous dialog among practitioners. In fact, Nonaka's (2002) ''socialization'' refers to a process of creating knowledge through shared experience.

Shared experience and the concepts of context and domain are closely interrelated. Individuals learn to exercise judgment through the process of socialization, which is based on a socially constructed shared context (Tsoukas, 2005a). New knowledge is socially constructed *by* and becomes meaningful *to* the community within which it was constructed (Boer *et al*., 2002). Abstract formulations ultimately depend on collective, socially accepted definitions (Blackler *et al*., 2000; Polanyi, 1966; Nonaka and Takeuchi, 1995; Spender, 1996b; Toulmin, 1999; Tsoukas, 2005a). This is what Wittgenstein (1953) called ''forms of life'' (*Lebensformen*) and what Grant refers to as ''common knowledge'' (Grant, 2002).

Social constructionists understand knowledge to be a product of a collective, something that is developed communally over time (Blackler, 2002; Leonard and Sensiper, 2002; Seely *et al*., 1991, 1998, 2000) and is the ''outcome of people working together, sharing experiences, and constructing meaning out of what they do'' (Choo, 2000 p.395). Some theorists (Leonard and Sensiper, 2002; Polanyi, 1966; Tsoukas, 2005a) argue that ''personal knowledge'' exists in collaboration with ''collective knowledge.'' In other words, each member socialized within the collective encompasses the knowledge of the collective. Other theorists (Spender, 1994; Seely *et al*., 1998; De Long and Fahey, 2000; Boer *et al*., 2002; Boisot, 2002; De Carolis, 2002) believe that this socially constructed ''collective'' knowledge is embedded in, and is the possession of the collective itself, suggesting that ''collective'' knowledge is greater than the sum of the individual knowledge within the collective.

The KDP model's layers represent individuals that overlap along the *Z*-axis as a group or community (Figure 7). A loop is introduced into the model to reflect the social construction of knowledge, which is influenced by factors such as shared values, norms, practices, and group culture. These factors may not align with individual or organizational culture, values, norms, and practices.

While the model illustrates individual knowledge processes linearly, these processes interact with the group dimension throughout. Knowledge is constructed simultaneously at the individual and group level. Many scholars describe these knowledge processes as ''messy'' because the individual is not developing an understanding alone; instead, group members simultaneously influence and are influenced by these individual cognitive processes. Over time, this is how groups develop and use shared values and practices.

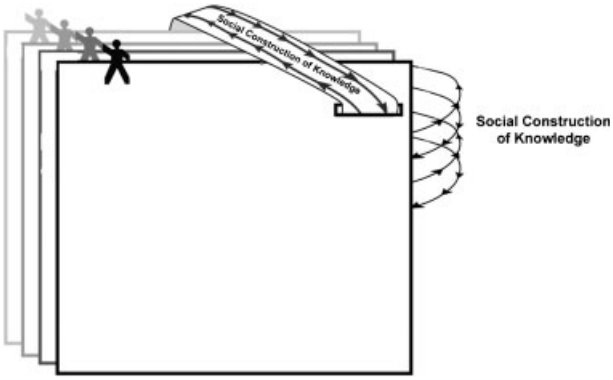

Figure 7 Group influence

Organizational context

Organizational context (Figure 8) helps individuals and groups understand the organization's KM and information management initiatives and practices. Organizational context guides effective KM behavior (e.g., information-seeking and use), decision-making, and systems design within the organization.

Although there are many elements and theories concerned with organizational context, this paper is most interested in how organizational context guides behavior through the development of organizational norms. With respect to KM, the most important organizational norms are cooperation, reciprocity, and trust. Organizations may attempt to drive these norms through culture,

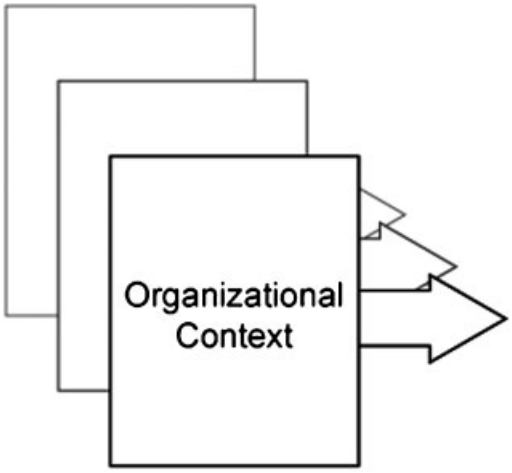

Figure 8 Organizational context

values, explicit organizational statements (directives, principles, policies, and procedures), initiatives, and reward structures. Organizational context is disseminated to individuals and groups through socialization and knowledge artifacts.

Concept of time

The timeline, borrowed from Reilly's (2008) model, is used to indicate a potentially infinite number of past and future knowledge states (Figure 9). The model is a snapshot of any one present knowledge state. As the model moves through time, the data within the knowledge artifacts as well as the individual and community understanding (knowledge) will change.

This temporal principle is consistent with the literature on knowledge. Blackler (2002) argues that knowledge undergoes construction and transformation in its use, being consolidated or modified with the introduction of new stimulus (information). Knowledge is both constructed (created) and destroyed (forgotten or made obsolete) during this process (Boisot, 1998, 2002). This constant transformation makes knowing a ''continually emergent process'' (Thompson and Walsham, 2004, p.735). Knowledge is situated and hence it will inevitably change since the situation around the agent is constantly evolving and developing (Blackler, 2002). The changing situation around the agent will then alter the situated knowledge individuals possess or apply and this repeats cyclically. Blackler (2002) refers to this type of knowing as ''mediated'', where ''changes associated with new information...transform the contexts of action'' (p.59). Spender (1994) argues that circular processes of learning continue as long as there is activity. Nonaka (2002) similarly argues that knowledge creation is a ''never-ending, circular process'' (p.451).

INTER-PROFESSIONAL CARE

IPC is defined as ''the provision of comprehensive health service to patients by multiple health caregivers who work collaboratively [*across* professions] to deliver quality care within and across settings'' (Interprofessional Care Steering Commitee, 2007). IPC is used to illustrate the KDP model because IPC provides a knowledge-rich environment with heterogeneous groups delivering collaborative care. Many Canadian organizations promote, research, and implement inter-professional approaches to care; including: the Canadian Interprofessional Health Collaborative (2009); Health Canada (2004); Health Force Ontario-the Ministry of Health (Interprofessional Care Steering Commitee, 2007); the University of Toronto (2008); Memorial University (2009) in Newfoundland; and the University of British Columbia (n.d.).

A patient's story and encounter with an IPC team

To illustrate how the model can be applied, a fictional story has been constructed as a composite from a number of cases experienced personally by one of the authors in practice:

> *Athalia is an 80-year-old widow who lives alone in a suburban community. During a visit, her daughter finds her confused, with slurred speech and right-side weakness, and takes her to the community hospital. The emergency doctor diagnoses a cerebral vascular accident (stroke) with unstable diabetes. After ten days in the hospital, Athalia is discharged home with instructions to have full-time assistance and attend a rehabilitation program.*
>
> *Athalia moves to a different community to reside with family. A new family doctor obtains consent for the transfer of previous medical records and compiles a referral to Lakeside Rehabilitation Centre requesting a detailed assessment to determine rehabilitation potential and initiation of appropriate treatment.*
>
> *At Lakeside, the nurse reviews the referral and clarifies medical testing information with the physician to determine the priority and key team members required to conduct the assessment. An appointment is then*

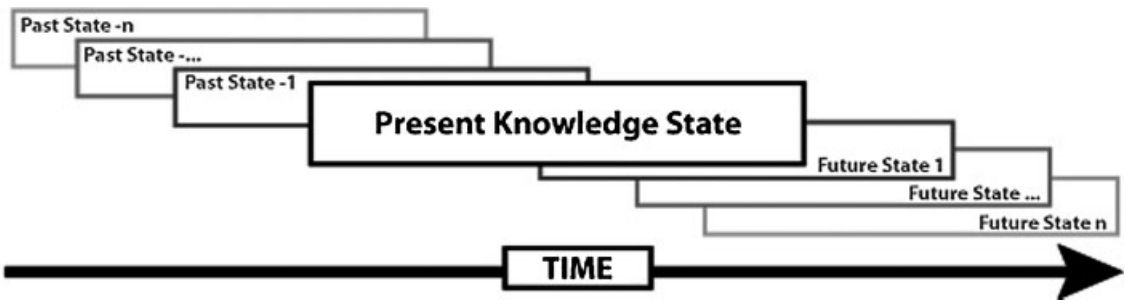

Figure 9 Temporal dimension

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arranged for Athalia to be assessed by the physician and physiotherapist.

The physician and physiotherapist conduct a joint interview reviewing medical history, current symptoms, functional limitations and patient goals. They support each other in information gathering by each taking a lead on sections of the interview, allowing the other to probe with specific questions. The physical examination is conducted similarly with both professionals in the room for testing and observation. The physiotherapist examines strength, gait, and mobility, while the physician assesses medical stability and neurological deficits. Once the assessment is completed, the nurse reviews some generic stroke recovery educational material with the patient and family.

The doctor and physiotherapist conference on their findings and agree that the patient is medically stable and suitable for rehabilitation. They provide the following goals for ongoing care:

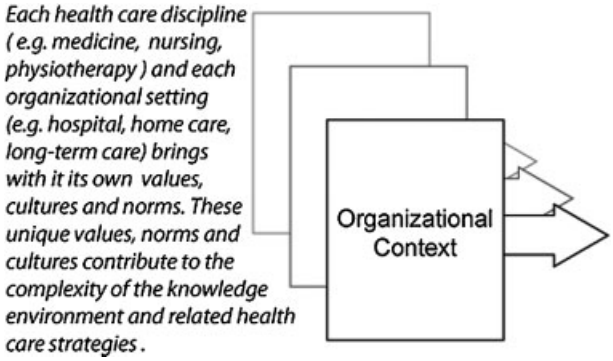

Figure 10 Organizational context and IPC

The organizational context is complex because of the various disciplines and professions involved: each with their own language, values, culture, and norms. Differences in professional language lead to barriers in sharing knowledge and developing a shared understanding of the patient's situation; this potentially compromises patient care (Figure 10).

Patient goals	Professional	Action
Medical monitoring of diabetes	Nurse (RN)	Coordination of monitoring lab tests, review of results, and diabetes education
	Physician (MD)	Identification of tests to be ordered and follow-up medical examination in six weeks after discussion with nurse on laboratory results
Neuromuscular strengthening program	Physiotherapist (PT) Kinesiologist	Detailed testing and provision of individual exercise plan as well as communication to kinesiologist for exercise class instructions and gait reinforcement
	Occupational therapist (OT)	Recommendation for OT to complete a detailed functional abilities evaluation to determine needs for task specific strengthening and identify need for assistive devices
Speech and language deficits	Physician physiotherapist	Both team members identify word-finding difficulties and question the depth of cognitive and insight difficulties. Request a speech therapist assessment
	Speech therapist	Recommendations for detailed speech therapy assessment to be shared at future team meetings for integration to care plan

The assessment team meets with the patient and family and communicates their proposed recommendations for further assessment and current treatment. The speech therapist joins the team to establish a rapport with the patient and family and to observe speech and language abilities.

Inter-professional care and the KDP model

In Athalia's case, health care professionals (doctors, nurses, physiotherapists, kinesiologists, occupational therapists, and dieticians; hereafter *the Clinicians*) work collaboratively to deliver IPC.

Filtering

Filtering processes are triggered by events such as a patient walking into a provider's office, the arrival of test results, or a patient's chart being retrieved by the provider (Figure 11).

Situate within a domain of action. To situate within a domain of action, each clinician, draws from their traditional domains of action and from events and knowledge artifacts. The Clinicians use a shared patient record that provides a central repository for collaboration. The domain of action used to interpret these events or artifacts is formed

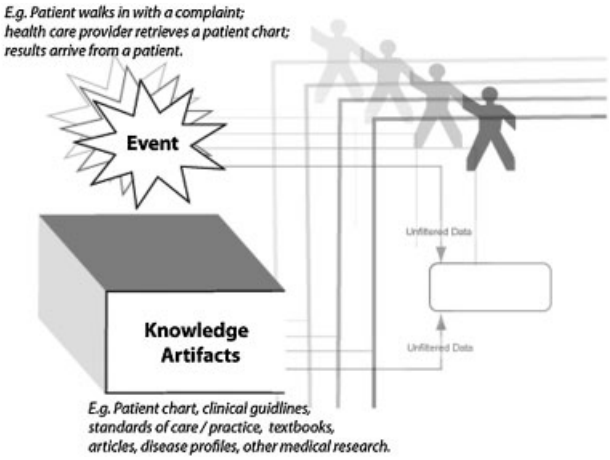

Figure 11 Knowledge artifacts and events in IPC

through the individuals' professional training and experience. Each provider brings specific competencies, skills, and professional expertise to the case (Figure 12).

The structure of and channel through which the domain is constructed (*form)* includes the literature (books, articles, research) of each individual's profession as well as the metaphors, analogies, and mental models learned through practice. The *content* of the domain is derived in part through the language (jargon and discourse) each profession uses and frames how each provider interprets data. Amongst other things, the *context* of the provider's domain of action will depend on the clinical problems being addressed (e.g., stroke and diabetes) and the setting in which the care is delivered (e.g., emergency rooms, primary care physician office, or a long-term care facility).

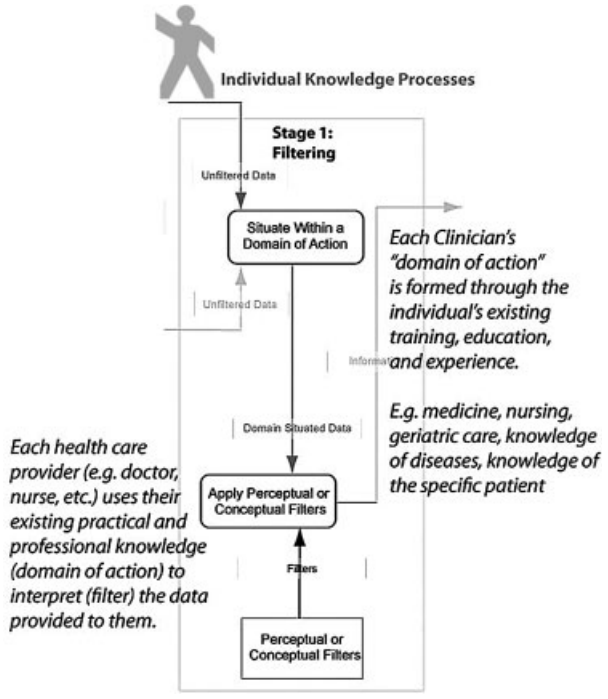

Figure 12 ''Domain of Action'' and IPC

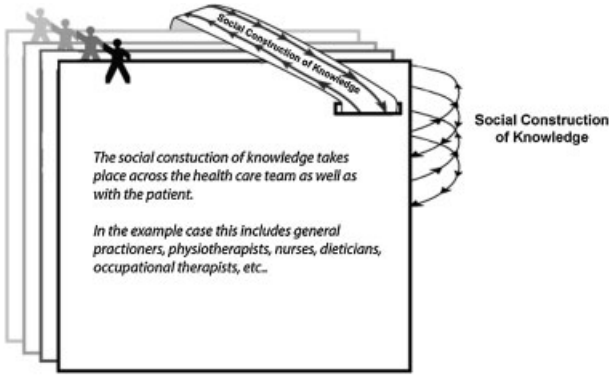

Figure 13 Group influence and IPC

To be effective, each of these practitioners must learn and decode from within their community and from other contributing professions and communities (Figure 13). The Clinicians need to understand each other in order to establish shared clinical pathways for Athalia. Each provider situates data about Athalia within a domain of action that reflects personal training and professional norms. However, interaction with other Clinicians, with their own domain filters, will call for a negotiated or shared interpretation.

Apply perceptual and conceptual filters. Practitioners apply perceptual and conceptual filters based on their professional training, experience, and expertise. Physiotherapists may examine a patient's symptoms through an exploration of musculoskeletal medicine. Speech therapists look at remedies for language and speech issues, and occupational therapists deal with activities of daily living. Family physicians take a broader view. The team will use contributions by all of these professionals as input for applying human judgment in developing treatment and care plans for Athalia (Figure 14).

Applying judgment

Apply abstract representations of the world. In Athalia's case, each profession and provider will have personal, abstract representations of an elderly female stroke/diabetes patient with a certain prior medical history. These representations, combined with each provider's domain of action, form cognitive models used to interpret relevant information. These representations incorporate any relevant ''in practice'' experience that contributes to the development of a shared diagnosis and comprehensive care plan.

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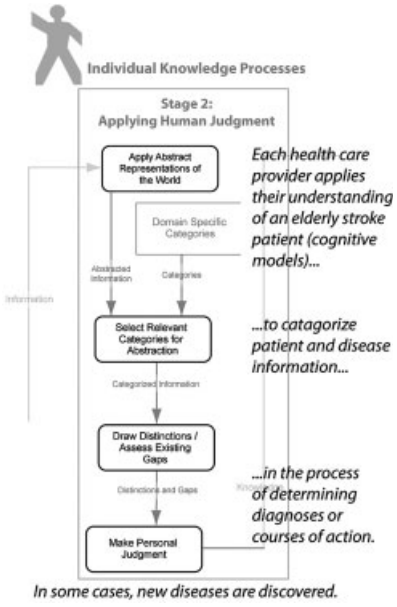

Figure 14 Making judgments in IPC

Select relevant categories for abstraction. Clinicians accumulate working lists of categories from their experience. Each professional on Athalia's team selects categories for abstraction based on prior experience and expertise. Experience is accumulated through formal and informal education as well as through interaction with other practitioners (inside and outside their own disciplines). This expertise is accumulated over time through interaction with similar patients such as other elderly women and diabetes/stroke patients.

When an elderly patient presents with cognitive impairments and memory deficits the practitioner creates a list of problems and differential diagnoses. Is it a drug or alcohol-induced impairment? Is it a stroke, or is it transient global amnesia? What the provider knows about elderly care, diabetes care, and other relevant domains is combined with the differential diagnosis, a variety of tests, possible outcomes, and treatments to deal with the patient's problems. This process is compounded throughout by interactions at the group level.

Draw distinctions/assess existing gaps. The distinctions Clinicians draw are influenced by their understanding of the abstracted categories. Clinicians learn to recognize symptoms and patterns and acquire a taxonomic framework for classifying patients and their problems. This includes the ability to recognize gaps in facts and information about the patient, resulting in further investigations, and introducing an iterative loop into the judgment process.

In Athalia's case, testing ruled out amnesia and impairment and focuses the health care team on an acute stroke diagnosis. The Clinicians narrow their distinctions by obtaining further facts, through physical examination, assessment, and tests. They may re-order, re-align, and re-design the facts in this analysis process looking for patterns to use as clues on the path to judgment. Providers consult with peers or other professions as information sources. Consultation across the care team provides a shared understanding and course of action. Collaboration on the group dimension is important, since no provider may have all of the information from which decisions can be made.

Gaps in knowing may be discovered in other areas as well. The professional may not know how to interpret facts presented, not having encountered the disease or problem state before. In some cases, new problems are discovered through the examination of facts. Clinicians manipulate (re-order, re-design, re-align) these facts or discoveries in ways that allow other Clinicians to interpret them (e.g., creating a genomic map or disease profile). Such was the case when SARS (a new virus) was discovered for the first time and when the H1N1 flu was first noted in patients.

Make personal judgments. Individual judgments made by practitioners are based on available information with their personal distinctions and gaps applied; but are also influenced by interaction with Clinicians. While each professional may make personal judgment(s) about Athalia's case (e.g., a diagnosis), this is often done collaboratively.

Constructing new knowledge

Build understanding. Knowledge is constructed from the case at both the individual and group levels and takes place across the care team and relevant knowledge communities. The understanding and expertise the care team brings to Athalia's case has been accumulated over years of individual training and practice in the field. This understanding includes generalizations about the patient (Athalia as an elderly female), particular problems (stroke/diabetes) and generalized knowledge that can be applied to other patients in similar situations (Figure 15).

Codify explicit knowledge. This new understanding contains elements that may be coded explicitly and reduced to data.[5] Unique cases that have not been

[5]For example, in health care, clinicians code: diseases (International Classification of Diseases), encounters (International Classification of Primary Care), and vocabularies/nomenclatures (Systematized Nomenclature of Medicine—Clinical Terms).

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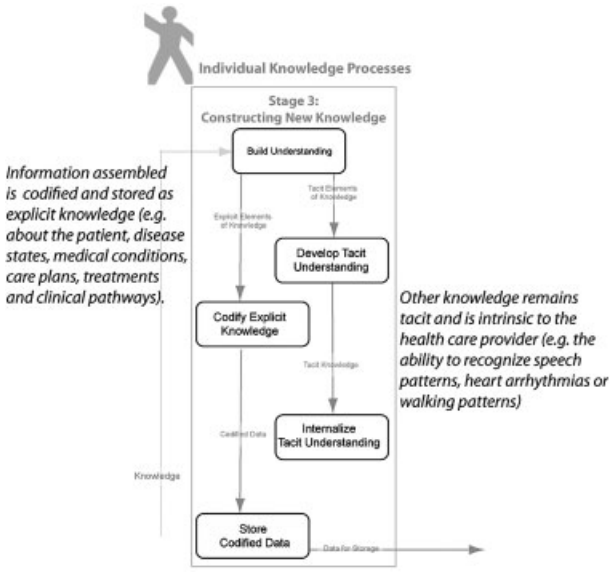

Figure 15 Knowledge sources in IPC

seen previously contribute to the knowledge of individual professionals as well as others in their field. Athalia's Clinicians may codify more than her specific information; the peculiarities associated with her case may be found in clinical rounds, cases, presentations, and research publications.

Store codified data. The codified data is stored in the form of knowledge artifacts that may be retrieved by the Clinicians or others. Some of this is generalized knowledge; others are specific to the patient and may be encoded in medical records (e.g., Ms Athalia's medical record, case notes, and observations).

Develop tacit understanding. Not all of the knowledge learned is explicit. The observations each provider makes in interacting with Athalia results in tacit understandings as well. As they work with Ms Athalia, providers develop their own cognitive models and perspectives. Each provider develops their own tacit knowledge, which shapes their abstract representations of the world (e.g., Athalia's case specifically and diabetes/stroke patients in general) and is re-applied in similar future situations. This internalized knowledge manifests itself as pattern recognition and intuitive feelings when dealing with similar cases.

Internalize tacit understanding. Tacit understandings are internalized into experience, skills, or expertise, which are used in future care delivery as Clinicians hone their skills over time. Experience is represented in an individual's own tacit expertise, which can be applied in other care situations (e.g., with other stroke patients). Each provider's personal experiences with patients will refine the cognitive models they apply to future cases. Clinicians refine their mental/cognitive models over time as new patient experiences contribute to the patterns they use to filter and recognize similar problems in the future.

CONCLUSION

Through the use of the KDP model, the authors present a more detailed understanding of the knowledge processes associated with the delivery of care in an inter-professional setting. In examining these processes through this lens, the authors demonstrate how the processes associated with making judgments and developing new knowledge can be better understood. The authors assert that the KDP model can be used and extended in other knowledge-intensive settings, given that human knowledge processes are similar across various knowledge domains and organizations.

In separating the filtering, judgment, and knowledge construction processes, the KDP model can be used by information and knowledge specialists to help design knowledge-intensive collaborative work environments such as enterprise search tools, decision support systems, case management, management of information systems, shared patient records, and portals. Examination of this model, and its various stages, should also lead to better understanding of the specific information needs and information behaviors at each stage. This will allow practitioners to build better information practices.

The model should be used as a lens for practitioners and researchers to examine and understand an organization's knowledge environment. The application of this model helps bring into focus the knowledge the organization has and any existing gaps in knowing. Such an understanding would be more thorough than through many of the existing methods and models.

In IPC, applying the model leads practitioners to think in greater detail about the roles each individual Clinician performs, their interaction with each other, and their system inputs and outputs. Similarly, the model assists organizations in identifying key individual roles, as well as, the data and information each role requires (or requests) from, and contributes back to, the system.

Another application of the KDP model is to map and describe key knowledge activities in order to design compatible work practices and processes. The detailed understanding generated by the model

DOI: 10.1002/kpm

assists in the re-design of organizational processes and associated knowledge strategies. For example, this analysis challenges the systems designer to consider both the needs of the individual providers and the team. Finally, the KDP model, and a more detailed understanding of individual and group knowledge processes, should allow organizations to develop hiring criteria that result in the selection, training and development of staff that promote and support effective norms and knowledge practices.

The authors recognize that, as an abstraction, this model may be overly simplistic and may evolve over time through use and refinement. The KDP model aims to provide researchers and practitioners with a more structured, detailed, and analytical way of looking at the processes involved in knowledge construction and dissemination. This model is viewed as a work-in-progress, as it is still under development. Use by others is encouraged and will help validate or refute the model in part or in whole.

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