Reconstituting knowledge management

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Abstract

Purpose – *The purpose of the paper is to improve traditional knowledge management models in light of complexity theory, emphasizing the importance of moving away from hierarchical relationships among data, information, knowledge, and wisdom.*

Design/methodology/approach – *Traditional definitions and models are critically reviewed and their weaknesses highlighted. A transformational perspective of the traditional hierarchies is proposed to highlight the need to develop better perspectives. The paper demonstrates the holistic nature of data, information, knowledge, and wisdom, and how they are all based on an interpretation of existence.*

Findings – *Existing models are logically extended, by adopting a complexity-based perspective, to propose a new model – the E2E model – which highlights the non-linear relationships among existence, data, information, knowledge, wisdom, and enlightenment, as well as the nature of understanding as the process that defines the differences among these constructs. The meaning of metas (such as meta-data, meta-information, and meta-knowledge) is discussed, and a reconstitution of knowledge management is proposed.*

Practical implications – *The importance of understanding as a concept to create useful metaphors for knowledge management practitioners is emphasized, and the crucial importance of the metas for knowledge management is shown.*

Originality/value – *A new model of the cognitive system of knowledge is proposed, based on application of complexity theory to knowledge management. Understanding is identified as the basis of the conversion process among an extended range of knowledge constructs, and the scope of knowledge management is redefined.*

Keywords *Complexity theory, Knowledge management*

Paper type *Research paper*

Introduction

The concept of knowledge has been actively discussed since at least the time of the ancient Greeks. Socrates, in *Theaetetus* by Plato (369 BC), conceptualized knowledge as a true belief with an account – commonly identified as the concept of justified true belief – but then indicated this definition remained inadequate. Knowledge has since received many definitions. A review of the existing literature shows the potential to improve understanding of the concept of knowledge. It is proposed here that the emergence of complexity theory indicates that the knowledge management field has reached a critical point and this provides the opportunity for new metaphors to convey the concept of knowledge, allowing better representation of its holistic and complex meaning. Indeed, existing models do not show the holistic and complex meaning of the concept of knowledge. This lack of integrated understanding holds back knowledge management and hinders understanding of the cognitive system. Insights from complexity theory will facilitate attainment of the next stage of knowledge management evolution (McElroy, 2000; Firestone and McElroy, 2003).

Complexity theory emphasizes the importance of non-linear relationships within a system. Therefore, it is not so much knowledge of the elements of a system that is important but more

DOI 10.1108/13673270810875822

comprehension of how they interact to form feedback systems. Complexity theory suggests that innovation and creativity occur when systems operate at the "edge of chaos," where they show emergent behaviors that enhance their ability to adapt to a particular situation of their environment (Bak, 1996; Capra, 1996; Stacey, 1996). Hence, complexity theory provides a framework to understand how knowledge forms at the level of individuals and then influences knowledge processing at the collective level of the organization (McElroy, 2000). A key presumption of this paper is that the concept of knowledge is scale free; it should apply in the same manner to individuals and organizations. Consequently, this paper proposes a reconstitution of knowledge management through the use of concepts borrowed from complexity theory.

The paper illustrates the search for consensus in the knowledge management literature regarding the definition of constructs related to knowledge, which logically leads to a re-examination of the differences between the tacit and explicit aspects of these constructs. It is then shown why understanding is the basis of the conversion process among data, information, knowledge, and wisdom. A novel extension of the traditional knowledge pyramid is proposed, expanding the boundaries of this system from Existence to Enlightenment. The E2E model is then introduced. Finally, it is demonstrated how the metas provide the concept needed to reconstitute knowledge management.

Defining knowledge: searching for consensus

The literature on knowledge management is replete with distinctions among knowledge, information, data, and wisdom (Nonaka and Takeuchi, 1995; Matthews, 1998; Awad and Ghaziri, 2004, Wiig, 2004; Hicks *et al.*, 2006). It is also common to see distinctions drawn between different kinds of knowledge, such as tacit and explicit (Nonaka and Takeuchi, 1995), actionable and passive (Wiig, 2004), or knowledge and meta-knowledge (McElroy, 2003; Wiig, 2004). Similarly, data are considered as broader than facts, which are typically treated as a form of proven or verified data. The linguistic origins of these terms shed some light on the derivation of their meaning (see Table I), but only broadly hint at the concepts as they are currently understood. Interestingly, the earliest recorded usage of each of the terms occurs in reverse order from their generally perceived level of simplicity according to the traditional knowledge hierarchy: Wisdom is the oldest term, and data the newest, in English.

As shown by Hicks *et al.* (2006), knowledge and information have received many definitions, without consensus. Among the multiple ways in which information has been defined are:

- data that makes a difference (King, 1993);
- data with special relevance and purpose (Drucker, 1995);
- data in context (Gallup *et al.*, 2002);
- data that has relevance, purpose, and context (Smith, 2001);

Table I Linguistic origins of key terms relevant to knowledge management

Term	*Origin*	*First recorded usage in English*[a]
Data	Latin (*datum, dati*)	1646, Hammond: "From all this heap of data it would not follow that it was necessary"
Fact	Latin (*fact, factum*)	1539, Henry VIII, Act 31 c. 8: "Euery such ... person ... shall be adiudged a traytour, and his *facte* high treason"
Information	Adopted from Old French (*informacion*), adapted from Latin (*informātiōn, informationem*)	1386, Chaucer: "Whanne Melibee hadde herd the grete skiles and resons of Dame Prudence, and hire wise informacions and techynges"
Knowledge	Middle English (*knaulage, knowleche*). Constructed on Old English and Teutonic origins	1300 approx., Cursor M.: "To mak knaulage with sum-thing Til sir august, bair ouer-king"
Wisdom	Old English and Frisian (*wísdóm*), as well as Old Saxon (*wîsdôm*)	888, Ælfred Boeth: "ba com bær gan in to me heofencund *Wisdom*"

Note: [a]*Oxford English Dictionary*, 2nd ed. under revision (2006), available at: www.oed.com/

- the result of human interpretation of data (Lueg, 2001);
- a result of analyzing and interpreting data that carries meaning (Bourdreau and Couillard, 1999); and
- structured data that supports decision-making (Laihonen, 2006).

Definitions of knowledge show even greater disparity:

- information whose validity has been established through test of proofs (Liebeskind, 1996);
- social actions (Stacey, 1996);
- a human, highly personal asset representing the pooled expertise and efforts of networks and alliances (Smith, 2001);
- the capacity to act (Argyris, 1993); and
- a set of insights, experiences, and procedures considered true and appropriate (Bourdreau and Couillard, 1999; Liebowitz and Wilcow, 1997).

Laihonen (2006) regarded knowledge as containing an interpretation of a knower, while Williams (2006) characterized knowledge as is dynamic, strategic, political, and subject to change.

Table II provides a compilation of alternative ways of defining data, information, and knowledge. This table demonstrates that there is no consensus within the literature of knowledge management, but it also shows interesting similarities. Most of the authors defined knowledge, fewer defined information, fewer still defined data, and almost none defined wisdom. Consequently, wisdom has been omitted from Table II although the concept does form part of the discussion presented here. Definitions of wisdom appear to be somewhat more consistent than those for knowledge or information. Ackoff (1989) defined wisdom as an evaluated understanding. Matthews (1998) described wisdom as the critical ability to use knowledge in a constructive way and to discern ways in which new ideas can be created. Awad and Ghaziri (2004) defined it as the highest level of abstraction, with vision, foresight, and the ability to see beyond the horizon. Most recently, Thierauf and Hoctor (2006) defined wisdom as the ability to judge soundly over time.

Would academics consider data to be the most basic unit of knowledge management? It seems so. However, as will be shown, this is open to discussion. Table II does show one area of agreement: There is a hierarchy among the concepts of data, information, and knowledge. The knowledge hierarchy is usually seen as a pyramid ascending from data to wisdom. However, Tuomi (1999) suggested reversing that hierarchy on the basis that data were more important than knowledge, also pointing out that knowledge had to come first in order to create data. A few authors (e.g., Nissen, 2002) proposed a dual approach, making a distinction between knowledge seekers and knowledge creators. From the seeker point of view, data is put into context to create information, and information that is actionable becomes knowledge. From the creator perspective, knowledge is needed to create information, which is in turn needed to create data. Therefore, it seems sensible that a general hierarchy of data, information, knowledge, and wisdom should permit transition in both directions – a notion supported by Williams (2006).

The following definitions of data, information, knowledge, and wisdom attempt to capture the common essence of the various definitions presented in the knowledge management literature:

- *Data* are considered to be unprocessed raw representations of reality.
- *Information* is considered to be data that has been processed in some meaningful ways.
- *Knowledge* is considered to be information that has been processed in some meaningful ways.
- *Wisdom* is considered to be knowledge that has been processed in some meaningful ways.

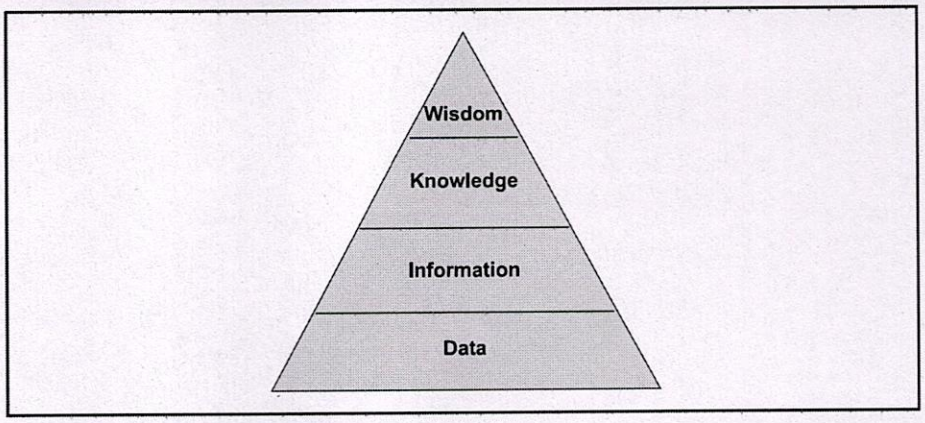
Table II Alternative definitions of data, information, and knowledge

	Data	*Information*	*Knowledge*
Thierauf and Hoctor, 2006		Structured data useful for analysis and decision making	Obtained from experts based on experience
Desouza, 2005	Transduced outputs of sensors	Fusion of data; creation of the network incorporating both data and the relationships among data	Placement of information in its larger context (a necessary condition for understanding)
Wiig, 2004		Data organized to characterize a particular situation, condition, context, challenge, or opportunity	Facts, perspectives and concepts, mental reference models, truths and beliefs, judgments and expectations, methodologies, and know-how. Understanding how to create new meanings out of isolated information
Awad and Ghaziri, 2004	Static, unorganized and unprocessed facts. Set of discrete facts about events	Facts based on reformatted or processed data. Aggregation of data that makes decision making easier and has a meaning, purpose and relevance	Higher level of abstraction that resides in people's minds. Includes perception, skills, training, common sense, ad experiences
Gallup *et al.*, 2002		Data in context	Integrated information in context
Dixon, 2000	Unsorted bits of facts	Data that has been sorted, analyzed, and displayed	Meaningful links people make in their minds between information and its application in action in a specific setting
Bourdreau and Couillard, 1999		Result of analyzing and interpreting data that carries meaning	Professional expertise appropriate for the domain. Things that are held to be true and drive people to action
Alavi and Leidner, 1999			Justified personal belief that increases an individual's capacity to take effective action
Applehans *et al.*, 1999	Measurements	A statement of fact about measurements	Ability to turn information and data into effective actions
Davenport and Prusak, 1998	A discrete, objective fact about events	Data that make a difference	A fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information
Liebowitz and Wilcow, 1997	Representation of a fact, number, word, image, picture or sound	Data that has been assigned a meaning	The whole set of insights, experience, and procedures that are considered correct and true and that, therefore guide the thoughts, behavior, and communication of people
Vance, 1997			Information that has been authenticated and thought to be true
Stacey, 1996			Social acts
Drucker, 1995		Data with special relevance and purpose	
Nonaka and Takeuchi, 1995		Data put in context. Information is about meaning	Justified true belief. Knowledge is tied to action.
Argyris, 1993			Capacity for effective action
King, 1993		Data that make a difference	
Goldman, 1991			Justified true belief
Ackoff, 1989	Symbols	Data that are processed to be useful	Ability to answer "How" questions
Aune, 1970			Information in context

In a traditional sense, data, information, knowledge and wisdom can not be mixed among themselves. New data, information, knowledge, and wisdom are respectively added to their established base. Figure 1 illustrates the traditional knowledge pyramid in which data, information, knowledge, and wisdom are perceived as distinct categories.

One area of potential controversy regarding the definitions and nature of the various knowledge related constructs relates to the distinction between tacit and explicit aspects. According to Nonaka *et al.* (2001), there are two types of knowledge: explicit knowledge and

Figure 1 The traditional knowledge pyramid



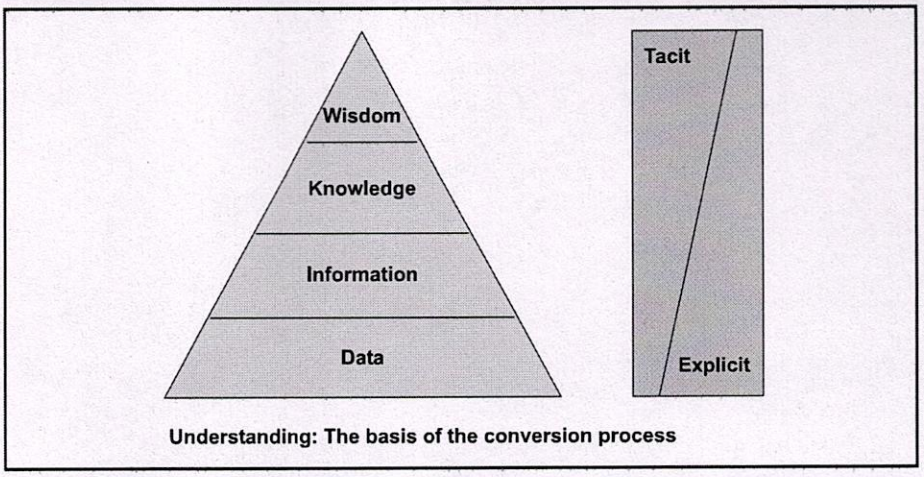
tacit knowledge. Explicit knowledge can be expressed in formal and systemic language, and can easily be shared by codifying it through many sorts of data, which can be stored. Tacit knowledge is less easy to handle, because it is highly personal and subjective; it resides in individuals' minds and is transparent (Selamat and Choudrie, 2004). Tacit knowledge is rooted into actions, procedures, routines, commitments, ideals, values, and emotions (Nonaka *et al.*, 2001).

Understanding the form of knowledge and knowledge creation implies recognizing this dualistic view of knowledge. This perspective has been commonly distorted to hold that data and information are explicit, and knowledge and wisdom are tacit (e.g. Heskett, 2002, Zeleny, 2006). It is also important to note that all tacit knowledge cannot be made explicit (Tsoukas, 2003). As suggested by Polanyi (1966) in *The Tacit Dimension* (p. 4), "formalizing all knowledge to the exclusion of any tacit knowing is self-defeating." Indeed, tacit knowledge is necessary to solve problems. As suggested by Plato in *Meno*, if all knowledge is explicit, then neither a problem can be known nor can its solution be looked for as it would be impossible to know that the problem exists. This is why Polanyi (1966) suggested that things that cannot be told can still be known. Therefore, knowledge management has to find a way to cope with tacit knowledge.

The distinction between tacit and explicit could exist all along the continuum between data and wisdom. Indeed, the authors postulate that data is not purely an explicit construct, and wisdom is not purely a tacit one. Information and knowledge display different levels of tacitness and explicitness as well. Information can be carried by human brains without being transformed into knowledge, as suggested by Alavi and Leidner (1999). The same applies to data, which may be carried in a tacit state; there is no universal requirement that it be transformed into explicit data. An example of this is provided by Monroe and Lee (1999), whose research suggests that buyers are influenced by data and information which are stored in their implicit memory. In the same way, one can discern explicit knowledge and wisdom. Folk sayings, or proverbs, are just one example of explicit wisdom (e.g. "a bird in the hand is worth two in the bush"). Some authors, including Ackoff (1989), have identified that explicit component of wisdom. Of course, knowledge is usually more tacit than data, but this implies neither that data is always explicit nor that knowledge is always tacit. Figure 2 summarizes this idea.

Bellinger *et al.* (2004) modified a hierarchy of knowledge based on the model of Berger and Luckman (1966), which transitions from data to information, knowledge, and wisdom through an increase of connectedness and understanding. The model uses an interesting framework: it is through understanding that data is transformed into information, then into knowledge and eventually into wisdom. Understanding is therefore identified as the transformational relationship among data, information, knowledge, and wisdom to create an outcome at a higher level. Although this model does not show whether or how one can

Figure 2 The knowledge hierarchy with the tacit/explicit continuum



transition from wisdom to data, it has the advantage of providing an initial holistic perspective by using the notion of connectedness.

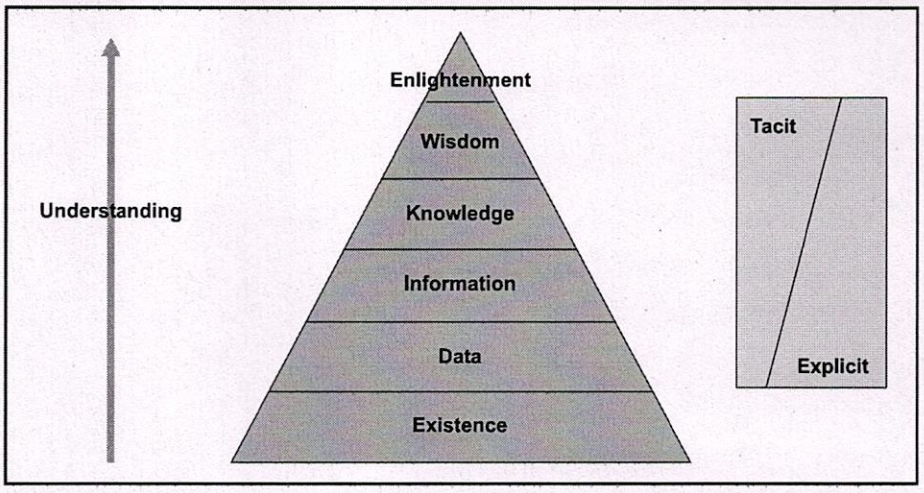
Redefining the scope of the hierarchy

All the definitions and models reviewed have led to a linear hierarchy, where data is the basis for information, which is the basis for knowledge, which is itself the basis for wisdom. The reverse of the ascent from data to wisdom is also possible, following the same reasoning. Authors can describe it as a pyramid, a hierarchy, or a circle, but it remains linear as there are no feedback loops. The first step for improving these models is to realize that they have neither a starting point nor an ending point. In other words, these models need clearer boundaries.

From Table II it is obvious that the literature focuses on defining the difference between information and knowledge, but little attention is paid to the definition of data. Data is not found in nature; it does not grow on trees, and it does not fall from the sky for free. Data have to be made out of something. Data are usually described as observations of reality. Back in prehistoric times, Cro-Magnons used pictographic representation for data while counting animals; later in history, Sumerians applied symbolic representations of data to capture and record grain harvests and other economic data. Hence, data are more that just observations; they are a level of understanding of existence. Existence describes the whole environment that humans can grasp and create data about. Data are a very basic processed outcome of human observation of existence. This idea of including existence in a more complete framework of knowledge is consistent with the ideas of the French philosopher Jean-Paul Sartre, whose classic phrase "existence precedes essence" (and therefore any abstraction of it) is considered the essence of existentialism (Sartre, 1956; Philosophy Pages, 2006; Wikipedia, 2006a, b).

Having addressed the "lower" boundary of the knowledge system, it is appropriate to turn to the "higher" boundary – seeking a state of being that will match existence, but constitutes a logical progression "upwards" from knowledge and wisdom. What is higher than wisdom? Buddhists refer to enlightenment as the awakening of beings. To awaken is to achieve a level of insight and understanding equal to that of the Buddhas (Van Hien Study Group, 2003). However, they make a distinction between awakening and supreme enlightenment, as there are many levels of awakening. It is not the intention of this paper to discuss metaphysics; however, it is useful in reaching the full scope of a hierarchy of knowledge. Enlightenment is the highest form of understanding. Therefore, it should be incorporated into a model that purports to represent a complete perspective on the hierarchy of knowledge. The result is illustrated in Figure 3.

Figure 3 The extended knowledge management pyramid



The above discussion of the extension of the traditional hierarchy is consistent with the idea of openness of complex adaptive systems. Indeed, it is suggested in this paper that not having the two constructs of enlightenment and existence means not taking into account the appropriate borders of the knowledge system. Consequently, traditional models such as the knowledge pyramid are closed systems. Because knowledge management would profit from complexity theory (McElroy, 2000), a more coherent model of the knowledge system should be open.

Existence and Enlightenment are two states of being which provide the boundaries of the knowledge system. Data, information, knowledge, and wisdom are cognitive constructs lying in between those two states.

While this diagram summarizes useful extensions to the traditional hierarchy it still does not embrace all the improvements possible by using ideas from complex systems. In particular, the diagram still shows a linear hierarchy and it does not show any feedback systems. For example, is it possible to create new knowledge by linking new data with previous wisdom? Can new information be created by linking previous knowledge and new knowledge? How can the need of knowledge to create or use data be depicted? All the models presented previously do not help to show the relationships that exist among data, information, knowledge, and wisdom. Linear thinking is holding back the creation of good metaphors to describe the concept of knowledge completely. Firestone and McElroy (2003) made an attempt at generating a non-linear model. However, they failed to see that their model was creating another kind of linear hierarchy. What is needed is a model without a linear hierarchy between data, information, knowledge, and wisdom, because - as shown later – they are all made up from the same basic unit. They are all labels used to structure human understanding of the same construct: existence. The real distinction among them is learning experience and understanding.

Redefining the basis of knowledge management

Simple mathematical notation can be employed to explain how data, information, knowledge, wisdom, and enlightenment relate to existence. The following is a metaphor to demonstrate this point. Data (D) is an abstraction of existence (X), therefore $D = a \times X$, a being the coefficient corresponding to the abstraction. Information is data that is processed in some way, so it can be reported as $I = b \times D$, b being a coefficient for the understanding that is required. In the same way Knowledge = $K = c \times I$, Wisdom = $W = d \times K$, and Enlightenment = $E = e \times W$. Therefore, the system can be described in the following terms:

$$D = a \times X$$

$$I = b \times D = ab \times X$$

$$K = c \times I = abc \times X$$

$$W = d \times K = abcd \times X$$

$$E = e \times W = abcde \times X$$

Consequently, everything is based on abstractions from existence. One can also argue that data is made of symbols (Ackoff, 1989), but that does not change the result because symbols are still abstractions of existence. Regardless of the type of concepts applied – such as meaning, judgment, or anything else – they are still all based on the same thing. What is important is the coefficient that differs among them. The distinction among these constructs is a level of abstraction and understanding. Therefore, a, b, c, d, and e all represent transformation through different level of understanding, the factor suggesting an exponential degree of thinking:

$$D = u \times X$$

$$I = u^2 \times X$$

$$K = u^3 \times X$$

$$W = u^4 \times X$$

$$E = u^5 \times X$$

It is also possible to use functional notation to express the same concepts, e.g. $K=a\,(b\,(c\,(X)))$ or $W=u^4(X)$.

Data, information, knowledge, wisdom, and enlightenment are transformations of existence. Therefore, the traditional hierarchy is obsolete, as it does not represent the totality of the possibilities. These equations emphasize that point by showing how data, information, knowledge, and wisdom could be portrayed from a different perspective.

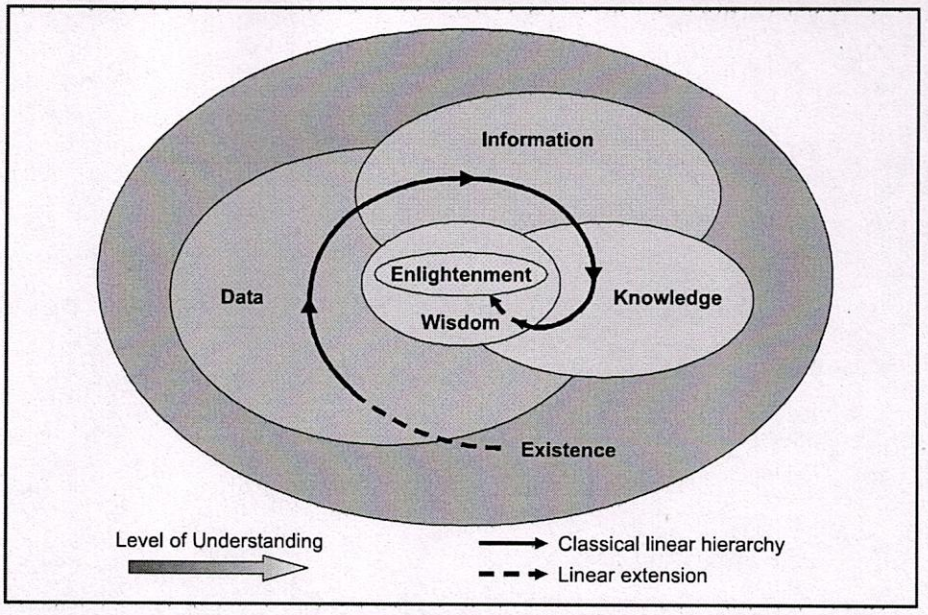
However, this is still not sufficient. Social interactions are the basis for the existence of data, information, knowledge, and wisdom. Indeed, according to many authors, data, information, and knowledge are linked through social interactions (e.g. Nonaka and Takeuchi, 1995; Firestone and McElroy, 2003; Wiig, 2004). The fourth form, wisdom, should be added to this list, and the possibility of cognitive (as well as social) interaction as a linking mechanism should not be overlooked. These four forms can interact in non-linear ways (as well as along the traditional linear paths). Hence, existence, data, information, knowledge, wisdom, and enlightenment form a feedback system with positive and negative feedback loops. This is a non-linear appraisal consistent with complexity theory, which helps to reveal the nature of the links among data, information, knowledge, and wisdom and helps to understand why the classical hierarchy is not appropriate.

The E2E model: rethinking the cognitive system of knowledge

The E2E model takes its name from the metaphor it represents. The model shows the cognitive system of knowledge and how understanding permits conceptual linking of Existence to Enlightenment. The E2E model accommodates the classical linear hierarchy of data, information, knowledge, and wisdom, and also incorporates the extension (on both ends of the hierarchy) from Existence to Enlightenment previously discussed in this paper. Figure 4 illustrates this.

"One area of potential controversy regarding the definitions and nature of the various knowledge-related constructs relates to the distinction between tacit and explicit aspects."

Figure 4 The E2E model – A complexity-based view of the cognitive system of knowledge



Existence, data, information, knowledge, wisdom, and enlightenment are all part of a cognitive system of knowledge. Cognition is the facilitation process through which the system functions; it is the process by which knowledge and understanding are developed. One implication of complexity theory is that a cognitive system of knowledge will emphasize what a system does, not what it is composed of. Note also that existence and enlightenment are two states of being. Therefore, cognition is involved at the transitional states between existence and enlightenment, but not at the two ends themselves. Indeed, data, information, knowledge, and wisdom are different cognitive constructions intermediate between these two states.

Contrary to past understandings of systems of knowledge, the authors claim that there is no hierarchy among data, information, knowledge, and wisdom. One does not need to obtain them in a specific order. Depending on the situation, one may not even need to have all of them. For example, a new receptionist employed by an organization may not have any specific data about the customers but may have the wisdom required to manage customer relationships based on values instilled during the receptionist's formative years. Hence, one can obtain information directly from an understanding of existence, without having to acquire any data enroute. In the same manner, one can create knowledge from data without having to create information as an intermediary. This is consistent with the premise of complexity theory that systems incorporate non-linear feedback; such transitions across state boundaries similarly take place in the cognitive system.

This cognitive system of knowledge is a social construct, the result of the interaction between a cognitive base (data, information, knowledge, and wisdom already possessed) and its environment through its existence. The cognitive base provides the history of the cognitive system, which is an important feature of complex adaptive systems (Bak, 1996). This implies path dependencies and the irreversibility of time, as argued by Prigogine (1997). All individuals have cognitive systems embedded in their mental processes. At a higher level, organizations also possess a cognitive system. Indeed, individual cognitive systems are constituent sub-systems of the organizational cognitive system. Again consistent with complexity theory, the cognitive system of knowledge is considered to be scale free as it exhibits self-similarity at different levels of complexity, i.e. individual, group, and organizational levels.

It is crucial to understand that it is the social interaction among people; established data, information, knowledge, and wisdom; and new data information, knowledge, and wisdom that will create valuable insights. Indeed, the cognitive base will help to create new data, information, knowledge, and wisdom, but it is the feedback engendered by these new data, information, knowledge, and wisdom that will enable cognitive creativity.

Newly developed or acquired knowledge can be used on an existing database to create new data, but can also lead to new information, knowledge, or even wisdom. Understanding is the power that generates new links among data, information, knowledge, and wisdom. New data can resonate with the knowledge base and lead to the creation of new wisdom. New knowledge can interact with old information and create a new understanding, which could mean the creation of new data, information, knowledge, or wisdom.

New data, information, knowledge, and wisdom can therefore emerge from the combination of newly developed or acquired data, information, knowledge, and wisdom and their respective established bases. The exact output depends upon the type of understanding that is generated within the system. Thus, the model shows how different levels of understanding are required to handle the different constructs of data, information, knowledge, and wisdom. Furthermore, the need for a higher level of understanding is linked to the tacit and/or explicit nature of these constructs. The higher the level of understanding that is required, the greater the chance that data, information, knowledge, and wisdom become tacit.

But if there is no hierarchy; and if data, information, knowledge, and wisdom are different levels of abstraction of existence, their definitions should be re-examined to verify whether they are still appropriate.

In this context:

- *Data* is a basic interpretation of existence. It is a purely descriptive construct that requires a low (categorical) level of understanding of existence.
- *Information* is viewed as a meaningful interpretation of existence, one that has a purpose. It is a connective understanding of existence. It requires a higher level of understanding than data, but a lower one than knowledge or wisdom.
- *Knowledge* is here defined as a meaningful and procedural abstraction of existence. It has a purpose and is a procedural understanding of existence. Without knowledge, lower levels of abstraction of existence are not actionable. Knowledge requires a higher level of understanding than data and information, but a lower level than wisdom.
- *Wisdom* is understood as a meaningful, procedural, and justified abstraction of existence based on experience. It has a purpose, relates to procedures, but it is also based on a coherent judgement of existence justified through experience. Wisdom therefore permits sound action and use of experience. Wisdom requires a higher level of understanding than data, information, and knowledge.

It is important to notice that these definitions do not imply a linear hierarchy. This means that, for example, information is not just data that has been processed in a useful manner. Furthermore, none of the definitions are linked to facts. It is thought that one needs to move away from using the word "fact" when defining such concepts as fact means "a thing that is known to be true". Indeed, it would add more confusion than precision to the definitions. Of course, data, information, knowledge, and wisdom are thought to be true by the people using them. But one needs to keep in mind that they are fallible. They are held to be true until proven wrong or superseded by something more coherent.

Why is wisdom not connected directly to existence in the model? Wisdom presupposes experience, and experience implies the presence of a cognitive base. Therefore, having wisdom means one already has some form of data, information, and/or knowledge. Furthermore, as has been discussed earlier, enlightenment is the highest form of understanding. It is not something to have; it is a state of being, such as existence. Therefore, it is separated from the rest in the model.

"The distinction between tacit and explicit could exist all along the continuum between data and wisdom."

Considering non-linearity also leads to a reconsideration of the role that "metas" play in this revised model for knowledge management. The idea of meta-knowledge is shown in many models (Wiig, 2004; McElroy, 2003), but this is not extended to meta-data or meta-information.

The metas and the reconstitution of knowledge management

Meta- has been used in the literature as something referring to itself, e.g. meta-knowledge being knowledge about knowledge (McElroy, 2003; Wiig, 2004). According to the *Oxford English Dictionary*, *meta-* means connected with a change of position or state, higher, beyond. Knowledge about knowledge is not meta-knowledge; it is just another kind of knowledge. It can be useful knowledge, but it has nothing meta- in itself.

Meta-data, -information, -knowledge, and -wisdom, are data, information, knowledge, and wisdom associated with a change of state; they are at a higher state of development, situated beyond (respectively) normal data, information, knowledge, and wisdom. So what are they exactly? The authors suggest that they are the essential subject that knowledge management should administer. They are the understanding of the conversion processes. Meta-data is the understanding of how data is transformed into another form, such as information, knowledge, wisdom, or a more complex set of data. Meta-knowledge is the understanding of how knowledge is converted into data, information, wisdom, or a more complex form of knowledge.

Essentially, the metas constitute understanding, or the form of knowledge traditionally termed "know-how," about how to extract, apply, abstract, and generalize from one level to another. However, it is not appropriate to describe the metas as just one form of knowledge as they are holistic constructs of understanding composed of data, information, knowledge, and wisdom about the conversion processes. What is interesting here is that the metas constitute understanding of how to pass from one level of abstraction to another (in both directions, to a higher degree or to a lower degree of abstraction, in single steps or greater leaps). Therefore, the search for and understanding of the metas is the core of the concept of knowledge management. (Note that this concept is to be distinguished from the practice of knowledge management, which typically concerns management of an organization's resources of data, information, knowledge, and wisdom, and interactions among them.)

Conclusion

This paper highlighted the lack of consensus on the definition of knowledge in the literature. However, it was possible to illustrate how all definitions agree on a common basis to define data, information, knowledge, and wisdom. Revisited definitions were provided. It was shown that data, information, knowledge, and wisdom could all be tacit or explicit, and that understanding is the basis of the conversion processes among them. The classical knowledge hierarchy was then discussed, and it was determined that it needed to be extended. Indeed, in order to attain the full scope of the knowledge hierarchy, it was necessary to add two concepts: existence and enlightenment. Consequently, a revised hierarchy was proposed (Figure 3). However, this paper has established how this type of thinking, even if it could be improved, is limited. What is needed is a holistic approach.

Therefore, the paper provides evidence that data, information, knowledge, and wisdom are all constructs based on the same process: abstraction of existence. What really differentiates these constructs is the level of understanding they require. The paper also

describes the cognitive system of knowledge and how existence, data, information, knowledge, wisdom, and enlightenment relate to each other by introducing the E2E model. This model is based on insights from complexity theory and emphasizes the non-linear and systemic basis of the cognitive system of knowledge. Complexity theory facilitates understanding of the meaning of knowledge management and the concept of knowledge. Finally, knowledge management has been reconstituted around the metas. The metas are the understanding of the conversion processes among data, information, knowledge, and wisdom. They provide a powerful new understanding of the concept of knowledge management.

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