Facts, Skills and Intuition: A Typology of Personal Knowledge

Abstract

This paper introduces a knowledge model in which the types of knowledge are formed according to the nature of knowledge. First we use Ryle's distinction of "that" and "how" knowledge, to which we add further three types. The five knowledge types are then synthesized using Polanyi's distinction of focal and subsidiary awareness. The resulting model distinguishes three types of knowledge, the facts, the skills, and the intuition; all three having focal and subsidiary parts. We believe that this knowledge model is comprehensive in the sense that can classify any knowledge and it also has great explanatory power, as it is demonstrated through illustrative examples. Moreover, the model is elegant and easy to use, which facilitates our understanding of the domain of personal knowledge. Therefore we expect our findings to be useful for both researchers and educators in the field of knowledge and knowledge management.

Keywords

personal knowledge, tacit knowledge, knowledge typologies, knowledge modeling, knowledge representations

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Although knowledge management has become a ‘buzzword’ in management research over the last few years, the importance of knowledge for companies was recognized a long time ago. For example, Marx (quoted in Marcuse 1964: 39) described the knowledge worker in the mid nineteenth century, and almost four decades ago Drucker (1969) introduced the concept of *“knowledge economy”* to draw attention to the fact that knowledge had became the single most important resource of production. More recently Drucker (2002a: 135) announced that:

“The most important, and indeed the truly unique, contribution of management in the 20th century was the fifty-fold increase in the productivity of the MANUAL WORKER in manufacturing. The most important contribution management needs to make in the 21st century is similarly to increase the productivity of KNOWLEDGE WORK and the KNOWLEDGE WORKER.” (Capitalization in the original.)

This paper aims to take a step towards this target assigned by Drucker, offering a model which facilitates better understanding of the nature of knowledge. This paper focuses solely on personal knowledge, taking on board Polanyi’s (1962a) conception. This does not mean that we neglect the importance of knowledge for organizations as presented e.g. by Drucker (Drucker 1969, 1993, 2002a), Senge (1990), Nonaka and Takeuchi (1995), Tsoukas (1996), Sveiby (1997), Davenport and Prusak (2000), Handy (2002), and Nordström and Ridderstråle (2002, 2004), nor that we neglect the effect of the organization on knowledge. Along with Tsoukas and Vladimirou (2001) we accept the Wittgensteinian conception that knowledge has profound social/organizational features, but these are out of the scope of the present paper.

This paper builds upon a body of knowledge encompassing a number of existing research inquiries into the increase of *personal knowledge* (e.g. Polanyi 1962a; Dörfler 2005). Our aim is to develop a knowledge model that gives account for all kinds of personal knowledge and which is, at the same time, sufficiently simple to use. The context of knowledge increase indicates one aspect of the significance of the model presented in this paper; i.e., as it will be shown, different types of knowledge require different types of knowledge increase. Another point of interest is that any activity of a knowledge worker typically requires a different blend of knowledge types, and thus being able to identify the constituents of the blend fosters better management of the knowledge workers. These will be illustrated through examples.

The motivation for constructing this new model is twofold: Firstly, we have noticed considerable similarities but also some differences between the existing models in the knowledge literature. Then, analyzing them systematically (as is presented later), we realized that the differences may be presented as a gap which may be covered by extending the models. Secondly, the motivation to do so stemmed from noticing discrepancies between what we experienced in our consultancy, research and teaching on the one hand, and what could be found in the literature on the other hand – that not all knowledge is covered by the known models. These two starting points merged into a single problem when our new knowledge typology was constructed. Whilst our model fills this knowledge gap we are sure that there are also other valid ways to fill it.

In this paper we first provide some discussion into definitions of knowledge. We do not aim at a definition ourselves but rather demonstrate that such an enterprise is problematic. Instead we want to give a rich description using metaphors to provide context for the paper. In the next section we give a brief overview of knowledge typologies in which types of knowledge are formed according to the nature of knowledge (as opposed for example to levels or topics of knowledge). We extend Ryle's knowledge model by introducing several new knowledge types as an interim stage to achieve completeness in the sense that any knowledge can be classified according to the model. These knowledge types will be later synthesized into a coherent whole, so that all the identified knowledge types make a single structured model. In order to achieve this synthesis, we give a brief overview of Polanyi's conception of focal and subsidiary awareness. This Polanyian model can be considered as a knowledge typology in itself; however in our case it will serve as the organizing principle of the previous knowledge types. Finally, we introduce our new model/typology as a product of synthesis and provide several illustrative examples to demonstrate the strengths of the model in use.

Knowledge of 'That', 'How', 'Why', 'What', and 'It'

In this section we review some knowledge typologies. Specifically, as this inquiry is addressing the nature of personal knowledge, we discuss the typologies in which the classification is based on the nature of personal knowledge. These typologies are based on or related to Ryle's (1949) knowledge model (which is extended here). Ryle asserted that not all knowledge can be described as a set of facts and propositions. We may know how to do things which we cannot necessarily formulate as a list of propositions. The knowledge of facts and propositions Ryle called *"knowing that"* and the knowledge of how to do things *"knowing how"*. According to the *"intellectualist legend"* (Ryle 1949: 22 ff) an act can be considered intelligent if, and only if, the person is thinking what (s)he is doing while doing it; in so doing the intelligent performance involves conscious observation of rules or application of criteria. It follows that the person first must acknowledge the rules or criteria and then devise a plan about what to do. Borrowing Ryle's (1949: 30) example this would mean that:

"The chef must recite his recipes to himself before he can cook according to them."

This would mean that 'know-how' can always be traced back to 'know-that'. If we accept this for a moment as a working hypothesis, we shall see that its implications lead to a contradiction (reductio ad absurdum). In other words, the assumption that we have to think in advance what to do before doing it would presuppose that before that we have to devise a plan of how to think what we would do, and so forth ad infinitum. There is another detail which is not explained by the "intellectualist legend": How do we know the maxims and propositions to consider, which are appropriate rather than the thousands which are not. Finally, the "intellectualist legend" also contradicts the observation that the person performing an operation well is often unable to tell the rules (s)he followed to perform that operation. For example, a comedian might be able to make good jokes but (s)he would not be able to tell us the recipes for them. Thus Ryle showed that 'know-that' and 'know-how' are both *valid* but *distinct* types of knowledge. Moreover, the maxims are condemned to absurdity if they are to replace the golfer's skill or the poet's art. (Polanyi 1962a: 31)

Anderson (1983) arrived at the same categories of knowledge as Ryle but coined different names for them. He speaks of *declarative* or *descriptive knowledge*, to emphasize that we store this kind of knowledge in a form that can be verbalized; and of *procedural knowledge* to indicate that this kind of knowledge manifests itself in the procedures we perform. It must be noted that performing certain operations correctly or efficiently or successfully does not necessarily account for knowledge of the performer. It is not enough if the action is well-regulated: the person has to be able to regulate her/his own action, to detect and correct lapses, to repeat and improve upon success, to learn from others' examples, etc. This distinguishes the act of a knower from a well-regulated clock or from a parrot.

Ryle (1949: 40-41) describes two different ways of learning to play chess. Usually the chess players learn the basics by receiving verbal instructions about the rules; they learn them by heart and can cite them on demand. During their first games they usually have to go over them aloud or in their mind, sometimes asking how the rules should be applied in a particular situation. Gradually they become able to follow/apply the rules without thinking of them. Importantly, at this stage learners usually lose their ability to cite the rules. However, it is possible also to learn chess without ever hearing or reading about the rules. One may observe how others play, starting to play by observing which of her/his moves are accepted and which are rejected. Gradually one may pick up the art of playing correctly without ever being able to propound the rules. The first type of learning chess focuses on an increase of ‘know-that’, but only at the beginning until the pupil learns the rules of chess. Later in the first type, and all along in the second type, the ‘know-how’ is increased. Furthermore, the ‘know-that’ is gradually converted into ‘know-how’ as the pupil becomes no longer able to quote the rules. This second type of increasing our knowledge of chess is *how we acquire* most of our common sense, as contrasted to special knowledge (Minsky 1988: 22):

*“Common sense is not a simple thing. Instead, it is an immense society of hard-*earned *practical ideas – of multitudes of life-learned rules and exceptions, dispositions and tendencies, balances and checks. If common sense is so diverse and intricate, what makes it seem so obvious and natural? This illusion of simplicity comes from losing touch with what happened during infancy… when we try to speak of them in later life, we find ourselves with little more to say than ‘I don’t know.’”*

If we dig deeper, we can find further knowledge categories that are not covered by ‘know-that’ and ‘know-how’. We may know how to perform a particular operation and detect and correct the mistakes, then even improve the process; this belongs to the domain of ‘know-how’. Yet, this does not necessarily mean that we would also be capable of creating this ‘know-how’ from scratch. The ‘know-how’ only means that we know *how* to do it, and perhaps how to adapt it to changing circumstances provided that the changes are not fundamental. But to *create* a genuinely new ‘know-how’, to *essentially alter* an existing ‘know-how’, to apply it in *radically different* circumstances, the ‘know-how’ is not enough. So there seems to be a deeper understanding, necessary to create a *novum,* although we can polish an existing process without it. This kind of deeper knowledge implies our appreciation of the fundamental principles. It goes beyond knowing how to do things in a certain way; it also includes knowing *why* things should be done in that certain way. To adopt a similar term to ‘know-that' and 'know-how', this new knowledge category could be named *'know-why'*. This is the knowledge of the creative problem solver when solving ill-structured problems by creating new solutions. Extending Ryle's previous example of the chef: if you do not have garlic, knowing *why* garlic was part of the recipe might help you find a substitution, e.g. in preparing some dishes you may use ginger instead. Independently Gurteen (1998: 5) recognized this knowledge type earlier than we did:

"In fact, know-why is often more important than know-how as it allows you to be creative – to fall back on principles – to re-invent your know-how and to invent new know-how."

To find a shortcut to the next missing knowledge category, consider once again the chef from the previous examples. He can make a *Cordon Blue* main course and a *Banoffee Pie* (amongst others) without reciting the recipes to himself as he 'knows how'. But, which one is he to make *tonight* for *her*? Knowing this is distinct from knowing *how* to make them or *why* they should be made a certain way, let alone the *that*-knowledge of the recipes. This is about *what to do* – thus we call this new knowledge category *'know-what'*. Drucker (2002a: 145), although never naming this type of knowledge, found it to be an essential part of the knowledge workers' assets to which knowledge managers must pay special attention if they want to increase the performance of the knowledge workers. The knowledge workers own the means of production; the job therefore needs them more than they need the job. The relationship of the organization with the knowledge workers is a partnership. You do not command the knowledge workers. You ask them what the task is, you use their 'know-what'. (cf Drucker 2002b: 86-87) Steve Jobs (quoted by Davenport and Prusak 2000: 50) offers a similar statement:

"It doesn't make sense to hire smart people and then tell them what to do; we hired smart people so they could tell us what to do."

The increase of ‘know-why’ and ‘know-what’ is somewhat similar to the increase of ‘know-how’. There is, however, an important difference: The increase of ‘know-how’ is gradual (albeit there may be step-changes in it); the other two knowledge types seem not to increase for long time, i.e. the knowledge increase is not manifest. The reason for this is that ‘know-why’ and ‘know-what’ both belong to *deep knowledge*. This can be observed in the previous descriptions of these two knowledge types; i.e. both are *beyond* the more apparent ‘know-how’. Deep knowledge builds on previous knowledge of other types and consists of more complex cognitive schemata (Mérő 1990: 153-155). The non-manifest nature of increase of ‘know-why’ and ‘know-what’ is one of the reasons these types of knowledge increase virtually always happen in a master-apprentice relationship. Only the master can recognize the almost imperceptible signs of the increased knowledge of the apprentice. Later, and apparently all at once, the apprentice shows a great leap in performance, often surprising everybody, including herself/himself. Only the master is not surprised.

There is only one further distinct knowledge type that we want to add to the Ryle-model. Let’s return to the chef one last time. When we left him previously, he had to decide what dinner to make tonight for her. If she tastes the dinner prepared by the chef, she might not know the name of the dish, which would be a ‘know-that’. She probably would not know how it was prepared or why a particular ingredient was used (unless she is a chef herself), which would be a ‘know how’ and a ‘know why’ respectively. And if she had an idea what dinner to make for someone, which would be a ‘know what’, it almost certainly would have nothing to do with what the chef decided to make for her tonight. But, tasting the dish, she will experience *what it is like*. As we already used the “what”, we can call this knowledge type *‘know-it’*. The ‘know-it’ is the personal experience of an event, its important feature being the personal nature of the experience. An essential feature of this knowledge type is the existence of *qualia*, the part of our experience that appears in our consciousness, accessible only via introspection and describable only in subjective terms. (Eliasmith and Mandik 2006) The term *qualia*, introduced by Lewis (1929), is probably easiest to understand through Jackson's (1982) famous thought experiment about Mary and the rose. Mary had grown up in a completely black-and-white environment; she was never allowed to leave her room and to see Nature. She had never seen any true color, everything was black and white. She had been educated about the colors, about the perception, about the biology of seeing. She had learned everything that could be learnt about colors from others, without actually experiencing anything in color. Then, when she leaves her room, she sees a red rose and passes out. There is something that cannot be explained, something that needs to be experienced personally. (See also Chalmers 2003)

As it can be seen from the previous description, the 'know-it' increases by experiencing the *qualia*. This is exactly what Russell (1948: 109-118) used as a starting point for his classification: The *non-verbal* or *sensational* knowledge is what we personally perceive or we expect to perceive in the immediate future, without the need for words. Russell uses the example of a slamming door for illustration: we see a door slamming and we close our eyes anticipating what is going to happen; if someone stops the door, we will be startled. We already experienced the qualia in our imagination. All other knowledge is acquired by the intermediation of words, that is, spoken words of someone, a book, a hypertext, etc. This category is the *verbal* or *narrative* knowledge. It cannot be explained to anyone who did not experience it what it feels like to be in love or, as in Mary's example, what colors are like.

Knowledge representations

Assuming we have covered all knowledge types, we can now try to further deepen our understanding of them. One way of doing so is to look at knowledge representations. These knowledge types served as basis for developing the concept of knowledge representations.

More precisely, *knowledge representations* refer to what is stored in the long-term memory (LTM); the term *"representational systems"* indicates that they also include, besides knowledge representations, the processes that operate upon these representations (Rumelhart and Norman 1988: 516). Rumelhart and Norman distinguish four categories of representational systems. However, here we are only covering three of these as the fourth, the distributed representational systems, are not really a different kind of representation in terms of the nature of knowledge. The role of distributed representations is to contrast the idea of superpositional representation to local models, meaning that the different pieces of knowledge are not stored locally but that somehow everything is stored everywhere. Thus the conception of distributed representations is underlying any or all of the other three representations. The following descriptions of the representational systems are largely based on the remaining three categories of Rumelhart and Norman.

The *propositional representational systems* were for a long time considered the only kind of representation, in the same way as the declarative knowledge, the 'know-that', to which it corresponds, was considered to be the only knowledge type. When it was recognized that this kind of representation cannot be described using *predicate calculus*, based on Chomsky's (1957) prior work on syntactic and semantic structures, Quillian (1967) developed the conception of *semantic networks*. In this model, knowledge is represented by a directed graph, where the nodes are concepts and the relations are associations. The idea is to capture the meaning of a concept in a node from the pattern of its relationships. Although this model fails to account for metaphors, it does a good job with most concepts and is widely accepted today. The easiest mode of knowledge increase in a propositional representation is to add new propositions. However, if we think in terms of semantic networks, we can add new concepts (symbols) and/or new relations. If we think of the meaning of a concept in connection with the pattern of its relationships with other concepts, the picture becomes richer: by adding new concepts and/or new relationships, the meaning of an existing concept may be altered as well.

The *procedural representational systems*, as the term suggests, correspond to procedural knowledge, to 'know-how'. It is possible to argue that in the background of any procedural representation there is a propositional one. The basis for this argument is founded upon computers, where programs and data are stored in the same way. However, it seems that knowledge of processes is represented in a different form from propositions. As Rumelhart and Norman (1988: 562-566) argued (see also Winograd 1975), distinctive characteristics can be observed for at least some processes: they are not available for personal inspection, they are remarkably efficient, heuristics are encoded in them, we are able to incorporate new knowledge within the same structure, etc. Thus we may distinguish the '*real* procedural representations' from those with a propositional representation 'in the background'. In terms of knowledge increase, the two versions would correspond to the two different ways of learning chess described earlier in this section. In the chess example we have seen that we can acquire the rules in the form of propositions (by verbal instructions), and we can also acquire them without words (by observing and practising). The opposite is not true however; there are some procedures that can only be acquired in the second way. For instance Davenport and Prusak (2000: 71) report on Prusak's attempt to learn hitting a baseball from Ted Williams' book. Though his performance actually improved somewhat, years later he attributes this improvement to his increased self-confidence. He claims that baseball cannot be taught through books. This can be explained if we suppose that hitting in baseball is the *real* kind of procedural representation.

The conception of *analogical representational systems* was originally developed by Shepard and his collaborators (see e.g. Shepard and Cooper 1986) and Kosslyn (see e.g. Kosslyn 1986) to account for the handling of images. There are certainly some parts of our knowledge that are not like symbols (concepts) and their relations (such as in propositional representations), but rather like images, such as pictures or 3D objects. The analogical representations not only account for standstill images and objects, but also images and objects going through various transformations. These mental transformations seem to have something important in common with real transformations, more precisely, with how we would *perceive* the real transformations (e.g. there is a limited spatial extent, so we do not 'see' the two opposite sides of a cube at the same time). The analogical representations are usually explained and examined using real images or physical 3D objects, but Rumelhart and Norman (1988: 556-557) suggest extending the use of analogical representations to *"smell of bacon and eggs"* and to *"sounds of a symphony orchestra"*. Thus they suggest the term *"mental models"* instead of images. It is probably clear up to now that mental models are the representations corresponding to 'know-it'. However, there is also evidence that the mental models can be *causal* models and that they can have some *abstract* components as well. Thus it would be sensible to assume that entirely *abstract mental models* may also exist. These abstract mental models could be the knowledge representations of 'know-why' and 'know-what'. And as these are newly introduced knowledge types, the corresponding representations have not yet been investigated. It is possible that new knowledge representations will have to be developed for a proper description, but the idea of abstract mental models sounds promising. We do not investigate the knowledge representations corresponding to newly introduced knowledge types; we discussed them only to inform our research on knowledge typology.

The obvious way of increasing knowledge in analogical representations is through experiencing, e.g. by seeing the objects and their transformations. However, there are less straightforward ways as well. We not only remember transformations that we have previously seen but we can create other transformations by merely imagining them; Rumelhart and Norman (1988: 556-557) call these *"mental simulations"*. An extreme example here is the maverickinventor Nikola Tesla, who was well-known for developing and perfecting his inventions ‘in his mind’ (Hong 2006) and building new machines without committing his ideas to blueprints (Tesla 1919: 11-12):

“Then I observed to my delight that I could visualize with the greatest facility. I needed no models, drawings or experiments. I could picture them all as real in my mind... Invariably my device works as I conceived that it should, and the experiment comes out exactly as I planned it. In twenty years there has not been a single exception.”

This means that using mental operations that operate on analogical representations, the creative problem solver increases her/his knowledge without external input. We may also acquire a new procedure operating on the analogical representation or some new view or a new transformation of an existing mental model, which increases our knowledge in that analogical representation. There is still another way of increasing knowledge in analogical representations: In the master-apprentice relationship, the master often uses parables, metaphors, and symbols to describe some abstract complex mental model. By doing so the master actually does not describe the model itself, but the parable somehow invokes the mental model. A similar case for figurative mental models would be when we hear a song or a poem about a landscape: the song or the poem does not actually describe the landscape in detail but still evokes the mental model of it. These kinds of phenomena cannot easily be brought under scientific examination. This is why Maslow (1966) and Grof and Laing (both quoted in Capra 1989) argue that we need a new language for science, a depictive rather than a descriptive language.

In this section we have revisited Ryle’s model distinguishing ‘know-that’ from ‘know-how’. We have added three additional categories, ‘know-why’, along with ‘know-what’ and ‘know-it’, the latter two are original contributions of this paper. The knowledge types reviewed in this section so far will be the building blocks of the synthesized model. In the next section we review Polanyi’s distinction of focal and subsidiary awareness, which will serve as an organizing principle used later in assembling the previously identified building blocks.

Focal and Subsidiary Knowledge

The idea of focal and subsidiary knowledge is based on Polanyi’s (1962a, 1966a) distinction of focal and subsidiary awareness. Understanding focal and subsidiary awareness requires, in turn, understanding the distinction between tacit and explicit knowledge. In his various works, Polanyi has developed a series of models about human knowledge, probably the most popular of which is usually cited as the ‘tacit-explicit knowledge’, with reference to his celebrated *“The Tacit Dimension”*. Interestingly, Polanyi actually never used the term *“tacit knowledge”* in this particular book; he consequently talked about *“tacit knowing”*. This curious fact is mentioned only as an early sign that in this section we will have to engage into differentiating *knowledge* from *knowing*. For the present discussion we start from Polanyi’s (1966b: 4) original point of departure:

“I shall reconsider human knowledge by starting from the fact that we can know more than we can tell… So most of this knowledge cannot be put into words.”

For the complete picture it should be noted that Nickols (2000) added a third category to this model, the *“implicit knowledge”*. This is tacit knowledge that can be made explicit. It is impossible to determine *ex ante* which part of the tacit knowledge can be made explicit, only *ex post*, that is, once it already has become explicit. Thus this third category is redundant and therefore is not considered in the present research. However, it *does* carry an important message that there is a transfer between the tacit and the explicit domain (see later in this section).

Building on a number of experiments and observations (such as face-recognition, using a probe to explore a cavern, the use of a stick by a blind person, unawareness of particular muscles during a movement, use of tools), Polanyi (1966b: 7-19) defines the structure of the tacit knowing, borrowing metaphors from anatomy (11):

"... we are aware of the proximal term of an act of tacit knowing in the appearance of its distal term; we are aware of that from which we are attending to another thing, in the appearance of that thing."

For further clarification the use of these terms is illustrated through an example. When exploring a cavern using a probe, the 'prober' concentrates on the end of the probe which is in her/his hand, and also on feelings in fingers. So the prober focuses on the near end (proximal term) of the probe, yet is not really interested in the vibrations in hand which are caused by the probe but rather in what is at the far end of the probe (distal term), the cavern. In this way (s)he soon forgets having a probe in hand and starts to picture the cavern. This is what is meant by attending *from* the proximal *to* the distal. Knowing the proximal is tacit, because we do not identify it, while knowing the distal is explicit, because we do identify it. (Polanyi 1966b: 18) Probably the simplest example from a more abstract domain would be understanding words. We see a series of letters or hear a series of sounds, yet we focus on the meaning of the word. This can easily be generalized to larger entities of the same sort, such as poems or novels.

This description of the structure of tacit knowing is also along the line with Neisser's (1967) idea of the constructive approach to cognition, which is probably the best expressed by the example he quotes from Hebb (p. 94 for perception and p. 285 for remembering): we perceive/remember fragments of bones and we see a dinosaur.

Polanyi originally described the increase of tacit knowing as a tacit process; and that the structure of the process of knowledge increase can be described in the same manner as tacit knowing, in terms of its proximal and distal parts. For instance in an experiment by Lazarus and McCleary (quoted in Polanyi 1966a: 5), the subjects were presented with a large number of senseless syllables and administered electric shocks after certain syllables. The subjects after a short period of time showed symptoms anticipating the electric shocks after these syllables, without ever becoming explicitly aware of the relationship between the shocks and the corresponding syllables. Another important form of increase of tacit knowledge is the previously mentioned master-apprentice relationship. The precondition of knowledge increase in master-apprentice relationship is that the disciple must believe that the master knows (Polanyi 1962b: 69):

"... the methods of scientific inquiry cannot be explicitly formulated and hence can be transmitted only in the same ways as an art, by the affiliation of apprentices to a master."

The obvious way of acquiring explicit knowledge is by means of words, i.e. explicitly. Henceforth this kind of knowledge increase will be called *learning*. Apart from learning, as it was indicated earlier in this section, explicit knowledge may also increase by *"articulation"*, when some tacit knowledge may become explicit. An example for 'articulation' is the tacit knowledge of a domain specialist, (a part of) which may become explicit as the domain expert teaches a novice. Similarly, some explicit knowledge may become tacit by *"internalization"* (Nonaka 1991: 4). For instance, when we learn a grammatical rule in a foreign language, we can put it into words – so it is explicit. Later we forget the rule (we cannot articulate it anymore) but we still use it perfectly when writing – it has been 'internalized'.

When describing the act of knowing, Polanyi (1962a: 55-65) realized that we are differently aware of proximal and distal. We have *focal* awareness of the distal and *subsidiary* awareness of the proximal. In the case of probing, the cavern is in the focus, and the prober has subsidiary awareness of the feelings in palm, vibrations, etc. Using the example of reading: the meaning of the text is in the focus and there is a subsidiary awareness of the letters, grammatical rules, etc. This conception comes very near to front-of-mind (focal) and back-of-mind (subsidiary) attention as expressed by Davenport and Beck (2001).

What is in focus requires focal attention and, as shown by numerous researchers from the field of psychology (Cherry 1953; Broadbent 1958; Deutsch and Deutsch 1963; Treisman 1964; Sullivan 1976; Anderson 2000), that kind of attention can be paid only to one thing at a time. There is also substantial experimental evidence (e.g. Eysenck 2001: 130-148) that, at the same time, we can also pay subsidiary attention to several things simultaneously. How many things we can pay attention to is determined by the capacity of the short-term memory (STM); which is estimated at 7±2 'slots' (Miller 1956). We can pay subsidiary attention to 6±2 (which should be understood as a metaphor for the 'remaining available capacity' rather than an exact number) particulars while focusing on one whole entity. Merging the focal-subsidiary attention with the proximal-distal metaphor, we can say that we pay focal attention to the distal and subsidiary attention to the proximal. Furthermore, as we have found that knowing the proximal is tacit and knowing the distal is explicit, we can also say that *focal attention* is characterized by *explicit knowing* while *subsidiary attention* is accompanied by *tacit knowing*. This basically means that we can explicitly identify what we are paying focal attention to, but we cannot explicitly identify what we are paying subsidiary attention to (Polanyi 1966b: 18). These characteristics are summarized in the first three rows of Table 1.

The above discussion focused on Polanyi's original train of thought, and thus it relates the proximal-distal distinction to subsidiary-focal awareness and then to explicit-tacit knowing. However, in this paper we are engaged with modeling *knowledge* not *knowing*. As was noted earlier, *knowledge* is mental content, a potential that can be transformed into actual performance through the act of *knowing*. Knowing is a process in which knowledge is used, such as learning, thinking or applying knowledge. Consider the example of writing again, now from the viewpoint of explicit and tacit *knowledge*. To put it in a simpler form: what can be learnt or taught about writing in a classroom? As we said above, what can be acquired by learning (by means of words) is explicit knowledge and what can only be acquired tacitly is tacit knowledge. This means that letters, words, and rules of grammar belong to the explicit domain (i.e. these can be thought and learnt in a classroom) but we cannot teach in a classroom how to write a good poem (i.e. it belongs to the domain of tacit knowledge). As it was said previously, letters, words, and the rules of grammar are the particulars (proximal term, subsidiary attention), while the poem corresponds to the whole (distal term, focal attention). So, the subsidiary knowledge is explicit and the focal knowledge is tacit. (More precisely the subsidiary knowledge *may be explicit* cf: the example of learning chess.) This can happen as the subsidiary knowledge of the particulars goes through the process of integration into the emerging focal knowledge of a whole entity (Polanyi 1966b: 18-21), and this knowledge of the whole entity is tacit.

The tacit-explicit relation is now reversed. Previously we have found that, in terms of *knowing*, the distal is characterized by *explicit knowing* while the proximal is characterized by *tacit knowing*. Now we have found that, in terms of *knowledge*, the distal is characterized by *tacit knowledge* while the proximal is characterized by *explicit knowledge*. While we can explicitly identify what we are focusing on (focal knowing), we are unable to actually provide explicit description of this content (focal knowledge). Conversely, we cannot identify the particulars of the subsidiary attention (subsidiary knowing). However, if someone would point these out for us, we might be able to provide explicit account about the content of such particulars (subsidiary knowledge). The root cause of the difference is that knowledge refers to the tacit-explicit *nature of the content*; while the tacit-explicit knowing is about *identifying this content*. Henceforth we only deal with focal-subsidiary knowledge, not with knowing.

Insert Table 1 about here

The argument we have presented in this section is far from trivial. However, we believe that we have achieved two important things. On the one hand, we have deepened our understanding of knowledge especially through identifying the deep difference between the natures of knowledge and knowing. On the other hand, we acquired an organizing principle which will help us to synthesize the knowledge types from the previous section ('that', 'how', 'why', 'what', and 'it') into a coherent model.

The synthesis

In the previous two sections we have prepared the elements that will constitute our knowledge model. In this section our new synthesized knowledge typology is introduced; the 'that', 'how', 'why', 'what', and 'it' types of knowledge serve as building blocks, while the focal-subsidiary distinction helps to classify them. In the first part of this section, instead of going through a process of putting the constituting elements together one by one, we start from the final form of the model, and then we show how the elements fit into it. In the second part of the section we provide some illustrative examples of the power and the simplicity of the model by applying it to well-known phenomena which are not, or not easily, explained by the known models.

The New Model

In our new model we define three types of knowledge: ***facts***, ***skills***, and ***intuition*** (the rationale for the terms will be developed through the argument in the forthcoming paragraphs), each having *focal* and *subsidiary* subtypes. (Figure 1)

Insert Figure 1 about here

In the following paragraphs we will describe each type, establishing the relationships to the previous typologies; the summary of these relationships can be found in Table 2, and the discussion follows the columns of the table.

Insert Table 2 about here

Facts. The focal part of facts is the ***event***. This corresponds to the 'know-it', the knowledge is tacit, the representation is analogical, and this kind of knowledge increases by experiencing events. (Table 2) The subsidiary knowledge of facts is the ***evaluation***, i.e. the *rules* of evaluation. This is a 'know-that', which is explicit, the representation is propositional, it increases by learning. For example, the jump of a pole-vaulter is a fact (we are taking the viewpoint of the spectator). Its subsidiary part is the knowledge about the measuring standard and how that should be used. The focal part is the spectator's experience of the jump, the *qualia*. It includes, amongst many other things, the observation that the bar did not fall down. As we see, the focal facts are something much richer than what one usually calls 'facts'. The reason for this is that we usually call facts only those that we can be asked for, i.e. whether the bar fell or not. These facts we call (based on de Bono 1976: 12-14) *second-hand facts* and they belong to the domain of propositions, i.e. they are not focal but subsidiary facts. We can recite an endless list of propositions of any experience; so we can create countless second-hand facts about any focal fact. The essence of the second-hand facts is not their correspondence to the reality but the *controllability*; e.g. we can check in lexicons that Lee Harvey Oswald killed Kennedy, so it is a fact even if we cannot be sure if it is true. When someone tells us a second-hand fact, we perceive in addition a first-hand (focal) fact which contains the experience of the speaker, the environment, our own mood, etc. These additional focal facts may help later to recall the second-hand fact we were told.

Skills. The focal part of skills is the ***action***. The 'know-how', with a procedural representation of the 'real' kind. The subsidiary part is the ***practice***, i.e. the set of *rules* of practice (doing, behaving, etc.) and *second-hand facts* about practice which, similar to the case of subsidiary facts, is 'know-that' with propositional representation. For instance, the action is movement with a bicycle with the subsidiary rules of keeping the balance. It is possible to distinguish several kinds of skills. For instance, Polanyi (1967: 302) distinguishes between bodily and speculative skills, it is also possible to distinguish between social skills and crafts, etc. However, all these still belong to the same knowledge type, and thus we do not need such distinction in the present paper. The subsidiary skills can be increased by learning; although it is not the only way of acquiring the rules of a skill, as we have seen in the case of the chess player. The increase of subsidiary skills does not necessarily improve the focal skills; for example, knowing much about the engine does not necessarily make one a better driver. Superfluous subsidiary skills may even destroy the focal skill. Polanyi (1966b: 19) claims that too much subsidiary knowledge may do *"irremediable damage"* in case of subjects like history, literature and philosophy. Focal skills are increased by practising (training, exercising). It should be noted that the *'practising'* as a way of increasing the focal skill is not necessarily the same as the *'practice'* the subsidiary skill, although there is obviously an overlap. Particularly, practising may mean a smaller subset in non-real situation. For instance, it may make sense to practise hitting the "h" and the "y" consecutively on a typewriter, but we would not claim that it is the practice of typing. However, for mastering a skill, practising is not enough (de Bono 1993: 4):

"A journalist who types with two fingers will still be typing with two fingers at the age of sixty. This is not for lack of typing practice. Practice in two-finger typing will serve only to make that person a better two-finger typist. Yet a short course in touch typing at a young age would have made that person a much better typist for all his or her life."

This is what we do in elementary mathematics when we try to apply the learned formulas in textually described tasks. The teacher helps us increase the subsidiary skill (e.g. how to add x to both sides of an equation), which will enable us to perfect the focal skill. Besides, this practising the focal skills may also be increased by intelligent imitation in the masterapprenticeship relationship. However, this can also be broken down to an observing (experiencing events) and a practising part. Experiencing events and practising skills are both experiences, but while the former is *passive* the latter is *active*. This kind of knowledge increase is often referred to as *"learning by doing"* (Anzai and Simon 1979).

Intuition. Intuition can be established as a valid type of knowledge based on analyzing its features (Dörfler and Ackermann 2010); such analysis reveals two types of intuition. Such a picture of intuitive knowledge is completely coherent with the intuition as presented here. The focal intuition is the ***hunch***, when one senses the direction or the solution (cf Polanyi and Prosch 1977: 96 ff). Respectively, the 'know-what' (direction) and the 'know-why' (solution) belong here (cf: earlier section). Both kinds of focal intuition have analogical representations, which maps closely to Sadler-Smith and Shefy's (2004: 85) work, where they speak about imagery in relation to intuition. The subsidiary intuition is the ex post ***explanation*** which has to follow the rules of formal logic strictly, regardless whether it was *really* how the hunch happened or not. Similar to the previous two subsidiary knowledge types, the explanation uses second-hand facts. The subsidiary intuition is 'know-that' with propositional representation and can be increased by learning. To use these rules we also need practise, though this will not lead to intuition but to a skill of using the rules. Thus we can learn to use inductive and deductive logic as well as predicate calculus. Although the focal intuition is *abductive* (tacit reasoning), by applying rules of logic to come up with an explanation we gain, at least, some understanding of how intuition works. It is a useful image to describe *hunch* as applying a number of rules tacitly at the same time, as Simon (1987) did.

For now we must accept that we know very little about the increase of focal intuition. Indeed, we believe that the attempts to find the 'best way to improve intuition' (e.g. Behling and Eckel 1991: 51 ff) will remain futile. What we know is that one with deeper knowledge in a certain discipline will have a better sense for the essence. As Einstein (1933: 12) said:

"There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance, and this Einfuehlung is developed by experience." Simon (interview by Ross 1998) uses the example of Mozart to describe the importance of the experience: *"Mozart composed for 14 years before he wrote any music you'd regard as world-class."* So the hunch both builds on experience and transcends it in the 'Eureka!" moment. This can often be observed when experienced experts wander into new unexplored territories. (Sadler-Smith 2008: 257) To contrast increase of focal intuition to the previous two types of focal knowledge, we can say that those were both external experiences while the hunch increases by inner experiencing. This, as described by Polanyi for science and confirmed by Quinn et al. (1996) for management, normally happens by imitating the master's way of thinking and by practising to think differently. The master also provides the small but necessary instructions to keep the disciple on the right track (this is a similar role to the type-writing teacher in case of skills from the previous example) but, as Prietula and Simon (1989: 123) warn this is *"neither a shortcut nor a substitute for experience"*. There are also numerous techniques that can support the increase of focal intuition (Dörfler and Ackermann 2010).

To summarize, we identified three types of knowledge: facts, skills, and intuition. Each has a focal and a subsidiary subtype. Each subsidiary knowledge type is 'know-that' with propositional representation. It always consists of some kind of rules (evaluation, practice, and explanation respectively) and second-hand facts. As the subsidiary knowledge can be articulated, it can usually be characterized as explicit (although it may not be always explicit, e.g. it may become tacit through internalization). The typical increase of subsidiary knowledge is through learning and by articulation, although, as we have seen in Ryle's chess example earlier, it may also happen by observing others. The three focal knowledge types correspond to the remaining four types from the extended Ryle-model. Focal skills are 'know-how' with procedural representation. Focal facts are 'know-it' and there are two kinds of focal intuition, the ‘know-why’ and the ‘know-what’. Both the focal facts and the focal intuition use analogical representations. All focal knowledge types are tacit and they all increase by various kinds of experiencing: facts by experiencing events, skills by practising, and intuition by inner experiencing. In the second part of this section we provide several illustrative examples demonstrating the ease of use and the explanatory power of our model by applying it to well-known phenomena.

Illustration

Having defined three types of knowledge (with focal and subsidiary subtype each) we can observe that most acts of knowing are not limited to a single subtype, not even to the focal and subsidiary parts of the same type. Adopting this idea of multiple knowledge types operating at the same time, we can re-examine the earlier example of reading. We can find the following: While reading, the knowledge of letters belongs to subsidiary skills. The perception of words is shifting between the focal skill and the focal intuition; i.e. recognizing the word is a focal skill and understanding the meaning of the word is a focal intuition. Further knowledge types should be added to include the knowledge of grammar, previous experiences that we utilize for constructing the meaning, etc. Reading appears to be a very complex process. This multi-knowledge-type description can explain for example why we often do not notice that a word is mistyped. What we want is to get the message of the text. Thus the focal skill (recognizing words) and the focal intuition (to understand the meaning) work together to get us the message. An often quoted example can be seen in Figure 2. We can fluently read and understand the text, even though nearly every word is mistyped.

Insert Figure 2 about here

Another example of the use of the model would be logically opposite to the one above; it concerns the Müller-Lyer and similar illusions. For example, most people look at Figure 3 and see the left arrow longer than the right one. This fact is used by the opponents of the constructivist approach to perception as an argument which, they claim, single-handedly falsifies the constructivist stance. The constructivist approach to perception means assuming that what we see emerges from the interaction of the reality we are looking at and our personal knowledge. The opponents of constructivism claim that our knowledge has nothing to do with what we see. The argument goes that if you are *told* that the two arrows are of same length, you will still *see* the left arrow to be longer, so the knowledge (i.e. that they are of the same length) does not affect the perception.

Insert Figure 3 about here

The previous argument is deceiving. The knowledge of the (second-hand) *fact* that the two arrows are of the same length does not affect the perception. The reason for this is that seeing the length of the arrows is not a factual knowledge but a *skill*. And it can easily be experienced that if one practises seeing the length of different arrows in such situations, one's perception will improve. Furthermore, it seems that 'seeing through' these illusions is a kind of generic skill: the person practising several illusions becomes better at seeing the 'right picture' in cases of other illusions as well. In doing so, seeing the two arrow lengths and knowing the fact that they are of equal lengths belong to two different kinds of knowledge. This means that our synthesized model has demonstrated that the counter-constructivist argument is simply not valid – it draws a conclusion about one knowledge type based on the properties of another type. Similar examples can be easily found and we believe that if we can identify what type of knowledge some real-life experience belongs to we can gain better understanding of its nature and thus of how it could/should be handled.

The third example provides us with an illustration of the transfer of tacit knowledge. First, however, some background details are necessary. As it was indicated earlier, the conception of tacit knowledge was put forward by Polanyi (1966b) in his famous *“The Tacit Dimension”*. However, as Tsoukas (2005: 142) observes, it was Nonaka and Takeuchi’s (1995) *“The Knowledge Creating Company”* that made the idea so popular that it is *“nearly impossible to find a publication on organizational knowledge and knowledge management that does not make reference to or use ‘tacit knowledge’.”* Tsoukas (2005: 142) asserts that *“Nonaka and Takeuchi assume that tacit knowledge is knowledge-not-yet-articulated: a set of rules incorporated in the activity an actor is involved in, which it is a matter of time for him/her to first learn and then formulate.”* This he considers a part of the *“Great Misunderstanding”*. (Tsoukas 2005: 154)

In the case study provided by Nonaka and Takeuchi (1995: 95-123) and cited by Tsoukas (2005: 152-153), the developers of Matsushita’s Home Bakery (the first fully automated bread-making machine) sent Tanaka, a software developer, to learn bread-making from the famous head baker of Osaka International Hotel. The developers would use Tanaka’s newly acquired knowledge of bread making to build a superior machine. At one stage Tanaka was *telling* the engineers, who were also brought to the hotel to gain some experience in kneading and baking, what would be needed to make the bread better. Tsoukas argues that this *does not* mean that Tanaka’s tacit knowledge has been made explicit.

It has been said earlier, we can provide endless lists of statements (subsidiary knowledge) about any focal knowledge. This, however, does not mean that the tacit focal knowledge is *completely* articulated. In this our model agrees and supports Tsoukas’ argument. However, additionally, it can provide further details. We can argue that Tanaka’s focal skill (‘know-how’) was not transferred to the engineers, but she referred to their shared experience, which the engineers interpreted on the basis of *their* focal intuition (‘know-why’) and, based on this, improved the machine. We can further generalize this argument to gain better understanding of the master-apprentice relationship. The master does not create a replica of herself/himself, rather (s)he helps the development of a new master. The focal intuition of the master is not transferred to the apprentice, but a new focal intuition is gradually developed which involves all the personal peculiarities of the apprentice. Of course, the intuition of the master and of the apprentice will have certain parts in common, but they will by no means be the same. The same argument can explain the case study of Davenport and Prusak (2000: 84 & 95). This case study describes a failed attempt to capture the knowledge of the world's best aerial photo analyst in an expert system (95): *"When the project ended, the expert system was useless, but the system designer was said to be the second best analyzer of aerial photographs in the world!"*

The aim of the previous examples was only to illustrate the explanatory power of our model; the list could be infinitely expanded. We believe that this explanatory power is, apart from its simplicity, what really makes our model valid and important.

Conclusions

As is usual in the case of intuition, this model was not perceived in the way presented in this paper. First we intuitively arrived at the model and then spent months of work slicing and dissecting it to understand its nature in order finally to put it back together. It is fair to argue that by analyzing we lose something. However, together with Pirsig (1974: 87), we believe that something is also gained:

"When analytic thought, the knife, is applied to experience, something is always killed in the process. That is fairly well understood, at least in the arts… But what is less noticed in the arts – something is always created too. And instead of just dwelling on what is killed it's important also to see what's created and to see the process as a kind of death-birth continuity that is neither good nor bad, but just is."

The first aim we wanted to achieve with the presented model was completeness: we wanted a model into which all kinds of knowledge fit. We have tried hard to find counter-examples (by applying the model to our day-to-day observations) and, indeed, we made several minor revisions, but the model now appears to be all-inclusive. This does not necessarily mean that it is comprehensive, even if *we* believe it to be so. However, the process of constructing the model can become a useful starting point if someone finds a knowledge type that we had not accounted for. The same completeness could have been achieved by simply adding the three new knowledge types to Ryle's original model, but our model integrates these, and this integration provides additional understanding, for example, of the various roles of 'know-that' in the three knowledge types that we introduced. We showed a few examples of how the model directly facilitates better understanding by providing simple explanations to well-known but poorly explained phenomena, such as reading text with typos or the Müller-Lyer illusion. Thus we believe that our model has great explanatory power and it directly supports our better understanding of personal knowledge. Finally, we wanted a model simple enough to be widely used by academic researchers in the field of knowledge as well as by the educators of knowledge workers and knowledge managers.

The benefits of this model are twofold: Firstly, we believe that it offers a useful starting point for management researchers pursuing their inquiries into (or through) the field of knowledge. Secondly, it is our hope to provide a comprehensive tool for the educators of the knowledge workers. The first is only possible if the model is general, i.e. independent of the specific field in which it is used; the second requires that the model is applicable directly in business environment.

Having said this, it is also important to be aware of the limitations of the model. As stated early in the paper, we only included knowledge in the present investigation, omitting the other three cognitive potentials, namely instincts, the emotions and the potential to transcend (see e.g. Dörfler and Szendrey 2008). The model is developed and presented adopting a predominantly conceptual approach, although we compared and refined it according to our experience and used real life phenomena for illustration. However, this research does not include a purposeful empirical component. Therefore gathering additional illustrative examples and perhaps developing some kind of empirical testing (developing a way of testing is a research problem in itself) could strengthen the model by establishing the domain of validity and increasing its reliability. Finally, our model is only one approach to distinguishing between various types of knowledge, i.e. on the basis of the nature of knowledge. Knowledge types can and are being identified according to other features, such as the topic of knowledge.

According to our plans, the present model is only one in the series of models on knowledge and knowledge increase. We aim for a dynamic model of knowledge and then at a dynamic model of cognition. In relation to the present model, several questions need to be addressed in order to advance towards those more general models: What is the relationship between the knowledge types and the knowledge levels (as in Dörfler et al. 2009)? We know that intuition appears only in people with deep knowledge in a discipline (see e.g. Dörfler and Ackermann 2010; Dörfler et al. 2010) and that having shown intuitive capacity in one field does not invoke intuition in other fields. However, this relationship between knowledge levels and knowledge types needs to be refined and clarified. It was said in the section on knowledge representations that the semantic network model of propositional representations does not account for metaphors - can we obtain a knowledge representation that does? It is possible that a model only considering knowledge genuinely cannot account for metaphors. Perhaps a proper representation also needs to include other cognitive potentials, such as feelings and emotions. It is clear that we have a long way to go to get at the dynamic model of cognition. However, this one step, the model of knowledge types, is already useful in itself. It may happen that we shall never achieve our general goal, but we will certainly produce some other useful models along the way.

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TABLE 1
Whole and Particulars

	Whole	Particulars
Part	Distal	Proximal
Awareness	Focal	Subsidiary
Knowing	Explicit	Tacit
Knowledge	Tacit	Explicit

TABLE 2
Knowledge Typologies Synthesized

	PERSONAL KNOWLEDGE						
Type	FACTS		SKILLS		INTUITION		
Subtype	Focal facts: EVENT	Subsidiary facts: EVALUATION	Focal skills: ACTION	Subsidiary skills: PRACTICE	Focal intuition: HUNCH		Subsidiary intuition: EXPLANATION
Knowledge	Tacit	Explicit	Tacit	Explicit	Tacit		Explicit
Knowing	Explicit	Tacit	Explicit	Tacit	Explicit		Tacit
That/How/ Why/What/It	Know-It	Know-That	Know-How	Know-That	What	Why	Know-That
Representations	Analogical	Propositional	Procedural	Propositional	Analogical		Propositional
Knowledge increase	Experiencing events, internalization	Learning, articulation	Practising, internalization	Learning, articulation	Inner experience, internalization		Learning, articulation

FIGURE 1
Facts, Skills and Intuition

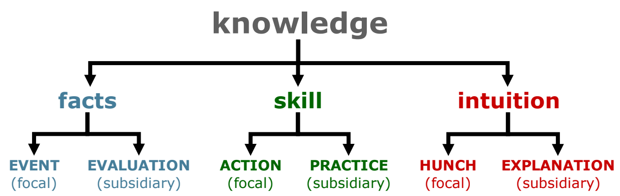
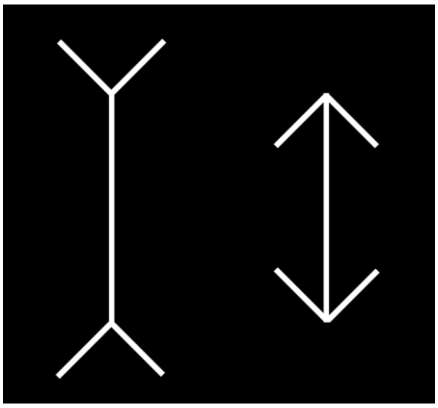


FIGURE 2
Is Spelling Important?

I cdnuolt blveiee taht I cluod aulaclty uesdnatnrd waht I was rdanieg The phaonmneal pweor of the hmuan mnid Aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer inwaht oredr the ltteers in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat ltteer be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Amzanig huh? yaeh and I awlyas thought slpeling was ipmorantt!

FIGURE 3
The Müller-Lyer Illusion[a]



a. Source: http://eluzions.com/Pictures/Illusions