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## Mental models: A robust definition

### Abstract

**Purpose:** The concept of a mental model has been described by theorists from diverse disciplines. The purpose of this paper is to offer a robust definition of an individual mental model for use in organisational management. **Design/methodology/approach:** The approach adopted involves an interdisciplinary literature review of disciplines, including system dynamics, psychology, cognitive science and organisational learning. **Findings:** Critical reflection on the published individual mental model definitions revealed similarities and shortcomings. It is argued that here the literature presents some consensus in the concept being internally held and having the capacity to affect how a person acts. The proposed definition of an individual mental model was found to be robust through a complexity based inquiry conducted in an organisation within the hospitality industry. **Research limitations/implications:** The application of the model has only been tested in one case study with a small staff sample in the hospitality industry. Thus generalisation is limited pending further testing. **Practical implications:** The pilot study demonstrated the usefulness of the definition of an individual mental model in making the conceptualisations of work practices explicit at various levels within organisations. **Originality/value:** This paper produces a definition that is lucid, inclusive, and specific for mental model research and knowledge management in organisations. The paper provides added value for academics and organisational practitioners interested in a robust definition for understanding the concept and the implications of mental models on an individual's actions. Emerald Group Publishing Limited.

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# **Mental Models: A Robust Definition**

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**Purpose-** The concept of a mental model has been described by theorists from diverse disciplines. The purpose of this paper is to offer a robust definition of an individual mental model for use in organisational management.

**Design/methodology/approach-** The approach adopted involves an interdisciplinary literature review of disciplines including system dynamics, psychology, cognitive science and organisational learning.

**Findings-** Critical reflection on the published individual mental model definitions revealed similarities and short comings. It is argued that here the literature presents some consensus in the concept being internally held and having the capacity to affect how a person acts. The proposed definition of an individual mental model was found to be robust through a complexity based inquiry conducted in an organisation within the hospitality industry.

**Research limitations-** The application of the model has only been tested in one case study with a small staff sample in the hospitality industry. Thus generalisation is limited pending further testing.

**Practical implications-** The pilot study demonstrated the usefulness of the definition of an individual mental model in making the conceptualisations of work practices explicit at various levels within organisations.

**Originality/value-** This paper produces a definition that is lucid, inclusive, and specific for mental model research and knowledge management in organisations. The paper provides added value for academics and organisational practitioners interested in a robust definition for understanding the concept and the implications of mental models on an individual's actions.

## **1. Introduction**

Wenger's (2004, p245) work with communities of practice and social learning contends that "shared practice by its very nature creates boundaries". It is therefore important to consider that boundaries not only connect communities but they also offer learning opportunities. Boundaries can be considered to be places where perspective meet or diverge and new possibilities arise. This paper will examine the concept of an individual mental model by expanding the boundary where perspectives meet or diverge and by providing a robust definition of a mental model for organisational research. This was done through a logical deduction of the literature that defines the concept of a mental model across many disciplines.

One way of getting into the minds of individuals in organisations and enhancing the link between individual and organisational learning, is through understanding the concept of a mental model. Mental models are important for the understanding of the construction of knowledge and the actions of an individual (Kim 2004; Senge 1990). Ultimately, organisational learning occurs through the individual members (Starkey, Tempest & McKinlay 2004). More specifically, mental models capture an individual's comprehension of a specific domain in their mind and, therefore, a mental model becomes an important construct for organisations and management to understand in order to enhance their learning (Miller 2003; Senge 2006; Starkey, Tempest & McKinlay 2004).

Although the concept of a mental model has been researched in various disciplines, the definition of what a mental model encompasses remains indistinct. Through a synthesis of the learning literature, it is revealed there is no robust definition of an individual mental model for organisational research. This paper fills that gap. This paper begins by exploring the current literature across disciplines and then goes on to propose the definition of an individual mental model for organisational research. From here the researcher has deconstructed and expanded on how the mental model definition was developed. The paper concludes by providing empirical support for the robust nature and usefulness of the definition in people and knowledge management in organisations.

## **2. Reconstructing the concept of a mental model**

### **2.1 Mental Models: An Ambiguous concept**

A key consideration when dealing with the concept of a mental model is defining and examining the aspects of the concept. In systems dynamics, psychology and cognitive psychology several theorists have followed independent paths in attempting to describe, and define the concept of a mental model. Thus, it is not surprising that there is no agreement about the definitions of mental models. Furthermore, in the process of attempting to define the concept of a mental model, terms such as cognitive maps or schemas have also been used to describe the same phenomenon.

According to system dynamics, the development of the concept of a mental model dates back to industrial dynamics where Forrester (1971) describes it as a mental image of the world that contains selected concepts and relationships. In contrast, fellow system dynamics theorists describe mental models as implicit causal maps

(Serman 1994) or a core network of familiar facts (Morecroft 1994) as held by a person. However, theorists in psychology define a mental model as having the same structure as the situation that it represents, or consisting of symbolic representations (Craik 1943).

Theorists in the interdisciplinary fields of human machine interaction, cognitive science, psychology and organisational learning have also provided varying definitions of the concept of a mental model. In the field of human machine interaction, Norman (1983) describes that mental models are formed by people of themselves, and of the things they interact with in their environment. This means that according to Norman (1983), a mental model must be functional naturally evolving, but need not be technically accurate. Cognitive science is the interdisciplinary (philosophy, linguistics, psychology, artificial intelligence, neuroscience, anthropology) study of the mind and its processes. As such it considers that the human brain is a physical symbol system (Miller 2003; Senge 2006). This means that the human brain can be described and explained by computational methods because “a symbol system does nothing but computation” (Senge 2006 p, 8). Whereas in the field of psychology, researchers define mental models as cognitive structures that serve different purposes, such as in schemas that perceive, and remember information about people (Fiske & Taylor 1991). In the organisational learning literature, the concept of a mental model can be deduced from Argyris & Schon’s (1978) theory of action. Argyris and Schon’s (1978) theory claims that our knowledge must be crafted in ways in which the mind can use it, in order to make it actionable (Fulmer & Keys 2004). Additionally, Kim (2004) describes the concept of a mental model as implicit and explicit understandings, ideas, memories and experiences.

It is evident, when reviewing the various definitions of a mental model, that the concept has been defined differently by multiple theorists across many disciplines. It can be suggested that these differences in definitions hinder communication among researchers, as the definitional aspects under the same generic terms continue to go unexamined and unnoticed (Doyle & Ford 1998).

## **2.2 Mental Models are internally held**

When the definitions of the concept of a mental model, provided by theorists across and within the disciplines, are compared, it is arguable that there is some consensus in the concept being described as being internally held. That is, within the mind of the individual. Several theorists describe mental models as being internally held (Craik 1943; Doyle & Ford 1998; Kelly 1963; Kim 1993; Senge 1990; Vazquez, Liz & Aracil 1996).

System dynamic theorists Vazquez, Liz and Aracil (1996, p25) describe their characterization of a mental model as a “psychological construction”. They use the term psychological to refer to a mental model as being comprised of an internally held structure (Vazquez, Liz & Aracil 1996). In 1998, Doyle and Ford reviewed and compared the concepts of a mental model looking for similarities and differences in the past definitions of the concept. They did this in order to develop their own unambiguous definition of a mental model, as specific as possible for their associated discipline of system dynamics. As a result, they describe a mental model as “something that exists only in the mind” and as an “internal conceptual representation” (Doyle & Ford 1998, p17). As an individual’s mental model is an internal representation of their external environment, it can be argued that a person’s mental model can be exhaustively described through following the symbol system it represents (Senge 2006).

According to Craik (1943) people construct and carry internal, symbolic representations of external reality in their minds. Kelly (1963) supports and expands on this view in his development of a theory of personal constructs. Kelly's (1963) theory describes a mental model as looking at the world through transparent patterns, created through a continuous, though changing correspondence with our minds. This means that mental models can be considered to have been constructed from an individual's own experience and thus their own bases of knowledge and concepts. The definitions provided by both Craik (1943) and Kelly (1963) from the discipline of psychology, have described a conceptualization of a mental model that is inherently internally held.

In organisational learning literature, Senge (1990, p175) describes mental models as "deeply ingrained assumptions, generalizations or even pictures or images". Similarly, Kim (1993) describes mental models as being an integrated interpretation. Both Senge (1990) and Kim (1993) discuss and imply in their definitions that mental models are internally integrated, or that we carry something in our heads, that is embedded in our minds.

Despite a difference in opinion regarding other aspects of the concept of a mental model, theorists (Craik 1943; Doyle & Ford 1998; Kelly 1963; Kim 1993; Senge 1990; Vazquez, Liz & Aracil 1996) have all defined the concept of a mental model as being internally held. It has also been determined that when a mental model is being referred to as being internally held, it means that it is something that exists within the mind of the individual, thus implying that it is a personally and internally created concept.

### **2.3 Mental Models affect individual actions**



Through a comparison of literature, it also becomes clear that the different effects a mental model can have as discussed by theorists, can be categorised according to how a person's mental model is thought to affect their actions. The dominant thought in psychology about the concept of a mental model is that "judgment, reasoning, and problem solving is based on the manipulation of complex mental representations that intervene between stimuli and behavioural responses" (Doyle & Ford 1998, p9). As the complex mental representations intervene between stimuli and behavioural responses, there is a possibility for the individual's actions to be affected.

Theorists in the discipline of system dynamics describe the concept of a mental model as important for providing information about the structure, and relationships in dynamic systems, as well as improving the quality of dynamic decisions (Doyle & Ford 1998). The aspect of improving the quality of dynamic decisions suggests that a mental model has the capacity to influence, or affect, how an individual makes judgements, and consequently affect how a person acts.

Moreover, a substantial proportion of the literature in cognitive psychology claims that a mental model is a part of how knowledge is represented in the mind. As a result, mental models are claimed to have different purposes, such as narration comprehension (Bower & Morrow 1990), or creating schemas or frameworks for understanding people (Fiske & Taylor 1991). These examples support the view that a person's mental model can influence such things as comprehension, judgement and understanding, thus affecting how an individual acts.

In organisational learning literature, the term 'mental model' is used for describing the related concept of a 'learning organisation' (Argyris & Schon 1978; Senge 1990),

or in describing the process of learning itself (Baets 2006; Kim 1993, 2004; Morgan 2006; Weick 1995). Specifically, mental models have been claimed by theorists to affect how we act and what we see (Senge 1990), while influencing our actions through their ability to restrict our understanding (Kim 2004). Additionally, Argyris and Schon (1978) based their theory of organisational learning on the premise that individuals shape their actions on their mental models. Kim (2004), Senge (1990), and Argyris and Schon (1978) further support the view that our mental models have the capacity to affect how we act.

The previous sections have outlined that the concept of a mental model is somewhat ambiguous. However through comparison and close attention to the definitional aspects of the concept, it can be argued that, there is some consensus in the concept being internally held and as having the capacity to affect how a person acts. Therefore, these aspects are important for consideration when attempting to understand what a mental model is.

### **3. A robust definition**

The previous sections have outlined how, although the concept of a mental model is somewhat ambiguous, comparison and close attention to the definitional aspects of a concept can reveal similarities across disciplines. It is argued that in the case of the definition of an individual mental model there is some consensus in the concept being internally held, and as having the affect how a person acts. The term 'mental model', when used in this definition, is referring to an individual's mental model; a mental model held by one person rather than the widely researched and discussed concept of a shared mental model. This definition is developed out of the similarities found in the literature and thus refers to a mental model as having the capacity to influence the attitudes, views, actions, behaviours and decisions of the individual,

including the capacity to assist and limit a person actions and or decisions in the workplace. Therefore, the concept of an individual 'mental model', when used as a term in this research refers to:

A concentrated, personally constructed, internal conception, of external phenomena (historical, existing or projected), or experience, that affects how a person acts.

This definition can be deconstructed as;

#### *Concentrated*

The word concentrated was specifically chosen to highlight the depth (Senge 1990), and rich intuitive detail (Richardson & Pugh 1981) of a mental model, while implying exclusivity, or close mental attention to a specific topic.

#### *Personally constructed*

When describing something as personally constructed, the subjective and personal nature of the phenomenon is highlighted. This important aspect is derived from Kelly (1963) who states in his theory of personal constructs that an individual personally builds constructs, and attempts to fit them over the realities of the world.

#### *Internal conception*

Internal conception is used to acknowledge that a mental model exists inside the mind of an individual. The internal aspect of the concept of a mental model is a common theme found when analysing the definitions provided by past theorists ( Craik 1943; Doyle & Ford 1998; Kim 2004; Senge 1990; Vazquez, Liz & Aracil 1996). More specifically by using the term 'conception' it is clear that not only do individuals carry small-scale models of external reality in their mind (Craik 1943) ,

but that these models are often incomplete internal conceptions of external phenomena.

*External phenomena (historical, existing or projected) or experience*

This phrase implies that for a mental interpretation to be called an individual mental model it must interpret something external to an individual's mind (Doyle & Ford 1998). Doyle and Ford's (1998) definition was an attempt to be clearer about the aspects of a mental model. However, in friendly but critical commentary, it was suggested that it is also useful to build models of entities that do not exist in their entirety outside the mind (Lane 1999). In consideration of Lane's (1999) suggestions for improvement, Doyle and Ford (1999) revised their definition to include external systems that are historical, existing or projected. In doing so, there has been significant improvement made by not excluding the idea that mental models can also be a referent for a system that existed at some point in the past (historical), or is planned, figured or estimated for the future (projected). This is of particular importance for inclusion in this definition as it makes it clearer by specifically not excluding the possibility of a mental model forming of phenomena that does not exist, in its entirety, outside of the mind (historical, existing or projected).

Additionally, the use of the word experience, reinforces that despite the nature of the mental model (historical, existing or projected), it remains that a mental model is developed through a subjective interpretation of an individual's experiences. This highlights that mental models formed by an individual, are subjected to being different to another's mental model, as individuals interpret experiences differently.

*Affects how a person acts*

A mental model has been described as having the capacity to affect how a person acts (Jensen & Rasmussen 2004). This aspect is important for inclusion in defining

the concept of a mental model, as organisational learning may only be demonstrated when selected ideas are effectively executed into practice (Chen 2005). This means that the successful organisation is one that understands and investigates mental models in order to use the knowledge learned from them to shape the actions of the individual or individuals (Chen 2005). This is achieved through the mental model influencing what an individual comprehends, as it is through an individual's mental models that they make sense and shape their response to correspond (Senge 1990).

#### **4. Empirical support**

The proposed definition described above has been tested in one organisation within the Hospitality industry. The definition was successful in identifying and understanding Management and staff's mental models about the current work practices in the organisation, and their views of ideal work practices.

The research method used was a complexity-based inquiry (Kuhn 2009) which involved semi structured interview questions. This is because the complexity-based inquiry method is a way of "gaining insight into why particular ways of organising to get things done arise and persist in organisations" (Kuhn 2009, p84). This was of particular importance to the research as it allowed for the adaption of the complexity-based inquiry methods, and metaphors, to the work practices by looking at my interest of concern, the mental models. The interview questions were shaped around the proposed mental model definition. This allowed the conversations with participants to be centred on how the participant views and feels about the work practices in the club, as well as what they feel to be their idea of ideal work practice. Additionally, by paying attention to what the participant says as well as observing how they are feeling throughout the interview by observing body language, the participant's mental model of the work practices were revealed.

Fundamentally, when the mental models of current work practices as held by management and staff were compared, they were found to be different. Not only are management and staff mental models different when compared, but individuals within the two researched participant groups were discovered to have different mental models. This is seen in the example below where within management; individuals have different understandings of the current work practices. Presented below are quotes from two participants making explicit their mental models of the current work practices:

Participant A

“I wouldn’t say they were good (work practices), I would say they are open to interpretation “.

Participant B

“We have got a lot of procedures but most are very loosely supervised or let go and forgotten even after a week”.

These Management participants have indicated that their mental model of the current work practices in the organisation are that they are not structured, open to interpretation by staff and not enforced. When the same two participants were asked of their vision of how work practices should be developed, or their actions towards how they may fix or deal with the current work practices, the individuals responded differently.

Participant A

“My belief is there should be someone in charge of training and given the time to train”.

## Participant B

“I think we should start trusting staff again”

To surmise, Participant A’s mental model of current or existing work practices was that they are ‘open to interpretation’. As a result their mental model of ideal or projected work practices is that ‘there should be training’ to ensure there is no room for interpretation. Participant B has indicated that their current, existing mental model of work practices is ‘we have a lot of procedures’. As a result their mental model of ideal or projected work practices is that ‘trusting staff’ would mean less procedures and less inconsistency. This shows that although a person’s mental model of the existing situation may be broadly similar to the person working next to them, mental models have the capacity to affect how a person acts, or responds as it was shown in this case. Moreover this proves that understanding individual mental models is imperative when it comes to the management of people and knowledge in an organisation (the detailed findings of this research are currently being edited for publication).

Above it was made clear that the proposed definition was satisfactory in revealing the mental models of work practices as held by management and staff, as it proved that across these two groups and within these two group individuals are influenced and driven by their own individual mental models when in the workplace. Below a participant’s mental model has been selected and focussed upon in order to further establish the proposed definition. The participant’s mental model unfolds as they are asked how decisions are made about what needs to be done in the organisation.

## Participant C

“Oh geez, really all I can say is everything here is on a reactive level and really only push factors push things through, there is no pull factor here to optimize

performance or anything like that, and everything is a critical push factor. What I do, and I'm very good at it, I have a very good memory for things so I just wait for a critical incident, and problem to just end up in my office... so what I do is I need to sort those things, so between you and me (pause) because no one is really looking at it because nobody wants to deal with the problem, I push everything that I know that is wrong through the place to fix the problem, but I will push everything else through I can, so I'm using a construct to fix other areas of the business on an excuse, but I have to wait for a critical incident. It's not as well managed as it could be, you don't maximise any of those things you're just pushing everything up a little bit further. It's really to address the organisation, coz I'm a very firm believer that good management is very silent, no one should really know, that's how it happens, and that's what I do and that's the only way I can really progress it"

#### *Personally constructed*

The personally constructed element of the participant's discussion becomes apparent through the consistent use of 'I' and reference to what they do and how they view how decisions are made in the organisation.

#### *Internal conception*

It is clear that the participant is discussing their internal conception of the situation as they explicitly describe their form of reasoning about decision making in the organisation. This is clear when they described "everything here is on a reactive level and really only push factors push things through, there is no pull factor here to optimize performance or anything like that, and everything is a critical push factor". By indicating that their own actions are a result of them being a firm believer in management being silent is also an indication of the internalised conception of the situation.



*External phenomena (historical, existing or projected) or experience*

The participant explicates an existing decision making process happening in the organisation. The participant also described their own experience of the external phenomena and how they react to the structure in place in the organisation.

*Affects how a person acts*

Most importantly, in this example it is clear how the individual's mental model of decision making in the organisation:

“Everything here is on a reactive level and really only push factors push things through, there is no pull factor here to optimize performance or anything like that, and everything is a critical push factor”

affects how they act, perform their job:

“So what I do is I need to sort those things.... I push everything that I know that is wrong through the place to fix the problem, but I will push everything else through I can, so I'm using a construct to fix other areas of the business on an excuse, but I have to wait for a critical incident”.

Fundamentally, the individual's internal conception that decision making in the organisation is on a reactive level has affected how they respond to making decisions and managing people in the organisation. Essentially, the above two examples prove that understanding individual mental models is imperative when it comes to the management of people and knowledge in an organisation.

## **5. Limitations**

The definition has been tested in one context, a small not-for-profit organisation set within the Hospitality industry. Currently, the researcher is in the process of testing the definition of an individual mental model as a tool for research in the different and wider context of Work-integrated Learning. The testing of the definition is also open for future research in other contexts.

## **6. Discussion and conclusion**

This paper makes the necessary step forward in clarifying the importance of the concept of a mental model. This paper synthesizes, analyses and evaluates the published definitions of mental models, both explicit and implied, across a range of disciplines. In doing this the paper has uncovered those aspects which researchers explicitly agree on, and the differences in opinion or omissions which have gone unnoticed or unexamined. The outcome of this process is a definition of an individual mental model proposed as a basis for future research.

A concentrated, personally constructed, internal conception, of external phenomena (historical, existing or projected), or experience, that affects how a person acts.

Mental models play a core role in such significant literature as Senge's (2006) work in creating and enhancing the link between individual and organisational learning through being able to sustain organisational memory and in being able to influence

the behaviour of the individual. Through a complexity-based inquiry the individual mental models of staff and management were revealed. These mental models proved to affect the individual's actions. Additionally, through a detailed deconstruction of a participant's complex mental model and how it illustrates the proposed definition the robustness of the definition is established. In essence, this paper contributes to the area of knowledge management in organisations through the development of a clear, inclusive and specific definition of an individual mental model for research.

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