A Model for Exploring a Broad Ecology of Learning and Knowing

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Abstract: This paper proposes a model that can be used to inform a strategic approach for the design, development, implementation and application of e-learning standards. It presents a working hypothesis that distills the abstract "problem space" spanning e-learning and knowledge management in holistic, simple terms. It does this by placing emphasis on the interrelationships between learning, knowing, and thinking within the context of a set of "primitive" questions: *Who, What, When, Where, How, Why,* and *If*. As such, it suggests a broad "ecology" of context. By concentrating on these primitive questions a degree of simplicity can be achieved while not masking the richness and complexity that must be accommodated. This approach highlights opportunities for future design and implementation of ICT systems developed to support learning and the creation and management of knowledge. Particular attention is placed upon *Why* questions as pivotal to sense-making.

Keywords: e-learning, epistemology, knowledge management, sense-making, metadata, knowledge representation

Introduction

Developing an informed and strategic approach to the design, development, implementation and application of e-learning standards requires inputs from a range of stakeholder perspectives. There are a number of reasons why. Firstly, e-learning is still very much an emerging field of practice that is finding application in many diverse settings (e.g., workplaces, formal education institutions, and home-based). Secondly, effective standards are fit for purpose, fulfill a real market need, or enable innovation – and without practitioner input they are of little use. Thirdly, a strategic approach may need to consider issues that involve pedagogical, technological, technical, epistemological, pragmatic, policy, and even political dimensions. This paper, however, does *not* attempt to cover all such dimensions and has been developed as a contribution to an *epistemological framework* that might 'balance' what are often very technical discussions in e-learning standards development.

Motivation for this paper has arisen by "re-thinking" the problem space that confronts innovators of information and communication technology (ICT) infrastructure developed to support activities associated with learning and knowledge creation. It asserts that the ICT infrastructure supporting e-learning and knowledge management (KM) (and, indeed, many other 'e' activities) has a high degree of commonality – for example, in the creation, sharing and stewardship of knowledge. This assertion is based on a common-sense proposition that thinking, learning, and knowing are all closely related [1]. It is an assumption that is validated by trends toward the modularization and integration of digital content and computational processes within an increasingly networked environment [2]. International projects such as the e-Framework for Education and Research demonstrate this in adopting

a ‘service-oriented’ approach to ICT infrastructure development and integration in higher education [3]. The challenge, and the central topic of this paper, is in the development of a hypothesis and supporting model that adequately represents this in a way that may then be used to inform future ICT innovation that supports e-learning and knowledge management.

Modelling typically involves abstract representations and can utilise either formal or informal methodologies. There are a number of Formal Description Techniques to choose from, such as Unified Modeling Language (UML). However, the prototype model in this paper has been developed informally, and very much represents a work-in-progress in organising key concepts. It is intentionally simplistic and two-dimensional but still aims to convey multi-dimensional relationships from which further complexity can be expressed.

In setting the scene for an elaboration of the model, discussion touches on the topics of networks, metadata, e-learning, and knowledge management in order to create background context for *why* the model makes sense. A working hypothesis is then presented.

1. Scanning the Environment

1.1 Our Networked World – Connecting Know-Who and Know-How

Advances in ICT infrastructure development are as much about networks as they are about technological capability. As such, there is an increasing interconnectedness of entities (human, organizational, and technological) that can share and exchange data, information, and knowledge – in other words, *connectedness* of *content* and *capabilities*. Numerous protocols and conventions enable such exchanges and these play an important role in supporting processes involving learning, knowledge sharing, and networking.

Networking is clearly *not* a new human activity and has been an essential aspect of communication that contributes to community sustainability [4]. All kinds of innovation from secret Australian aboriginal song-lines and North American Indian smoke signals to Web 2.0 applications and the Semantic Web can be seen as supporting networks – networks that share knowledge. In recent decades, however, the depth and reach of networks can be seen as approaching a profoundly ubiquitous state [5, 6, 7, 8, 9].

Historically, this represents the birth of a major era for civilization [10]. With the flows of information identified as a “key ingredient”, as Castells (1996) suggests it makes sense to consider how this might impact not only the configuration of classrooms in traditional educational institutions but also what the optimum channels for learning might be. Thus, as Mitchell puts it:

> “Today the network, rather than the enclosure, is emerging as the desired and contested object: the dual now dominates. Extension and entanglement trump enclosure and autonomy. Control of territory means little unless you also control the channel capacity and access points that service it.” [11]

For both learning and knowledge networking, then, connecting with others (peers, mentors, and experts as well as teachers and family) is an important activity in this environment. Doing so builds relationships that in turn enable new pathways of becoming or keeping informed. Importantly, it establishes perspective beyond the local domain.

1.2 The Role of Metadata – Who, What, When, Where

In the Web context, *metadata* represents a typical example of a mechanism that enriches content and enables linking and re-use of information – metadata being defined here as data that either describes or identifies other data or information.

Enabling effective resource discovery and information retrieval are thus the prime functions of metadata and essential for business efficiency and targeted online learning, education and training. However, metadata can itself function as data and can convey recursive contextual information, introducing layers of complexity [12].

One approach to dealing with this complexity is through Semantic Web technologies such as the Resource Description Framework (RDF), where metadata statements can express information about *relationships* between entities as well as the entities themselves. RDF and related technologies, because they can express or represent propositional aspects of knowledge, therefore provide a lot of potential in supporting learning and knowledge sharing. This dual characteristic of metadata has some similarity with Snowden's contention that knowledge is both a "thing" and a "flow" [13].

While there are a number of sophisticated software engines that enable effective resource discovery and information retrieval it is arguable that most metadata systems (including metadata that is imputed or assigned by algorithms) are biased toward processing descriptions, terms, keywords, or hyperlink weightings, and therefore have a limited capacity to parse semantics and infer sufficient context to handle anything other than simple queries. In other words, metadata that assists in discovery and retrieval is largely concerned with *aboutness*. Research and development in natural language search technology is aimed at addressing this deficiency and although advances are being made it is likely to be many years before such technologies will be sophisticated enough for 'prime time' [14, 15].

It is therefore argued here that metadata schemas such as the Dublin Core, MODS, and even the IEEE LOM (all developed specifically for the Web), can all be distilled to a core set of "primitive" questions concerning the basics of information: *Who, What, When, Where ?* These four questions assist in summarising the properties of a resource and establish essential context [16]. But when it comes to thinking, learning, and knowing there are other "primitives": *How, If, Which,* and *Why*. And these kinds of questions pose considerable challenges for how metadata might best be specified and configured for learning. Of the latter four primitives it is *Why* that appears to provoke the widest possible scope of response. It is a question that either demands a narrative rationale or it propagates further questions relating to context. It is the question that young children first ask as they start to make sense of the world. It is the question we all ask as we make sense of the world anew.

2. Clarifying Concepts: e-Learning and Knowledge Management

2.1 e-Learning

Since about 1998 when the term 'e-learning' first started appearing it has been appropriated by many communities of practice – from corporate training associations, to academic Web enthusiasts, to government policy makers, to software vendors, to military organizations just to name a few.

As e-learning develops as a field in its own right it will necessarily be accompanied by a discourse that refines its core concepts and terms as ICT innovations and trends change. Thus, historical perspective reveals that e-learning capabilities initially enabled by Web applications emerged from a context where traditional educational institutions commonly *delivered* course offerings in a *content-centric* manner. With the proliferation of networks as described above this is all changing. For example, in 2004, Boud observed:

> "The online environments in which learning networks operate today have emerged from a tradition of control and surveillance in which learners have been positioned as dependent on decisions made for them by those 'who know' what they need." [17]

The Learning Management Systems that have been a dominant feature of the e-learning software solutions market for the past 10 years can also be seen as rooted in established tradition. With the emergence of Web 2.0 applications it is becoming clearer that networked learning offers much more than the managed electronic delivery of curriculum content. The challenge for most K-12 school settings is how to enable broad e-learning experiences for students while maintaining a regulatory watch. Thus:

> "More than ever, what you say about the future of e-learning depends on how you define it. Seemingly for the traditional attempts to replicate classrooms and courses online, the future is fairly bleak. If however, you define e-learning as an environment, rich in context, interaction and opportunities for collaboration – then the evidence seems to point to a bumpy road but with a worthy destination." [18]

2.2 Knowledge Management

In a similar way, the knowledge management (KM) field is one that has emerged within the same timeframe as e-learning. It is typically understood as an organizational intervention in terms of management efficiencies but is also an evolving academic discourse.

The range of knowledge processes critical to the management of (organisational) knowledge was first generalised by Nonaka and Takeuchi as the interplay of tacit and explicit knowledge throughout four ongoing processes involving socialization, externalization, combination, and internalization [19]. Known as the "SECI model" it has provided a solid foundation upon which KM has evolved since the mid 1990s. However:

> "As the number of practitioners and academics multiplies in this field, so does the number of definitions and discussions with regard to these activities [of identifying, acquiring, enriching, applying, and transferring knowledge]." [20]

Despite these challenges there have been many very useful attempts at clarifying the concepts and terminology of KM discourse. [13, 21, 22, 23].

In many ways it can be seen that contributions to KM discourse that have followed the SECI model provide broader, rather than contrary, perspective on the domain. Because the SECI model has a compelling simplicity about it when modelling the processes and transformations in knowledge as it is acquired and shared, its core concepts continue to be recognised as important by KM practitioners the world over.

What is probably more significant to the evolution of KM discourse is the influence the rise of the 'network society' has in shifting the focus from being organizationally-centric to a paradigm that places emphasis upon emergence and complexity. [24] Seufert, Back, and von Krogh observe:

> "Concerning the integration of networking and knowledge management, we believe two aspects to be crucial. First, knowledge management should comprise a holistic view of knowledge, meaning the integration of explicit and tacit knowledge. Furthermore, knowledge management should take a holistic view on where and how knowledge is being created and transferred … The integration of networking into knowledge management yields great benefits. The openness and richness of networks … foster a fertile environment for the creation of entirely new knowledge." [25]

The influence of networks and networking upon KM suggests then that there is still plenty of scope for developing other models – models, for instance, that can not only represent the range of activities associated with managing knowledge but also the processes of creating and sharing it. While harnessing the flows of knowledge between networks would appear to be a natural domain for knowledge management the theory and practice of doing so is not necessarily so straightforward. This is borne out in a recent blog post by Sims (2008) in which an analysis of *53 knowledge management definitions* is presented:

> "General observation: this again illustrates the definition diversity. It is not like these are 53 definitions with slightly different word choice. These are substantially different. There are only five attributes that are seen in 30% or more of the definitions: KM is a process, it is targeted at the organization (company), it deals with knowledge, sharing is part of the story, and the definition includes a "*why*"." [26]

It is noteworthy in the context of this paper that *Why* has some prominence as one of the attributes having commonality.

3. The Sense-Making Model

3.1 Common Sense and Learning Theory

Figure I models a working hypothesis and represents thinking, learning, and knowing within an interdependent relationship that is intended to convey movement or activity. As indicated in the Introduction above, these activities are often likely to converge into the one experience. Common sense, after all, is a filter that enables us to make sense of things easily. It is when theoretical elaboration is pursued that such simple propositions reveal enormous complexity. Thus, anyone who has studied to become a teacher will know there are numerous theories of learning [27] – and, depending upon context, they can all be shown to have merit.

Figure I – The InterCog Sense-Making Model

In order to make sense of this complexity some commentators simplify the classification of learning theories into three "isms": behaviorism, cognitivism, and constructivism. [28] However, given that many of the established theories were articulated prior to the advent of the World Wide Web, Siemens has been recently advocated "connectivism" as a new theory [29]. While this theory is arguably a synthesis and re-presentation of earlier theories it provides important fresh perspective and presents a simplified vision that places emphasis upon the role of networks in learning in the "digital age". In many ways, Siemens' perspective aligns well with the working hypothesis in this paper.

3.2 Content, Context, and Community

> "After all, what do we know now that we didn't know ten years ago? That learning and knowledge are the result of multiple, intertwining forces: content, context, and community". [30]

Seely Brown made this comment in 1998 but it still seems to hold true. This is why these three influences are represented in the outer ring of the model. Again, movement and interconnection is also part of this representation.

Of course, no model can ever capture the whole picture and any one model will only ever have limited utility; and, one person's holistic approach is often another's tunnel vision! Thus, Hodgins has recently presented a similar model in which content, context, and *competencies* are seen as the three pre-eminent interdependencies. [31]

3.3 Seven 'Primitives' – Who, What, When, Where, How, If, and Why

Figure I has taken a number of years to develop and has been influenced largely by considering the challenges associated with defining metadata schemas that are not only adequate in networked environments but are sufficient when applied to processes of learning and knowing as well as resources that support these processes. Various iterations of this model have included more 'primitives' (fundamental question initiators) than the seven represented (e.g., *Will, Whether,* and *Which*); however, these primitives appear to be of a second order to those that seem critical to sense-making.

The most significant conclusion concerning mainstream metadata schemas, then, is that they are primarily designed to accommodate variations and extensions of *Who, What, When*, and *Where* information. Following this observation the working hypothesis of the InterCog Sense-Making Model (ISMM) is that these four fundamental questions are the primitives of information discovery. That is not to say that they do not support learning and knowing – they do! But what is characteristic about them is that they tend to be most applicable to the *description of resources*, as opposed to *processes*. Properties associated with these primitives also contain objective information. An important question arises from this: how might metadata schemas (and therefore, standards) designed to support learning and knowledge creation evolve if they are to extend beyond these four 'core' primitives?

The ISMM also represents three other primitives and the working hypothesis is that these three primarily represent the primitives of learning and knowing. They seem fundamental to making sense of the world and in the construction of knowledge about it.

How questions will typically yield answers that are procedural in nature. *If* questions generally trigger a following question (*If-Then, If-Will, If-What,* etc) and can be modeled in rule-based terms. Regarding *How* questions and their broader interrelationships within the global networked environment, Harryson comments:

> "The innovation process is no longer limited to intracorporate know-how, but leverages instead global know-who. Know-how is the ability to solve problems efficiently based primarily on internally accumulated knowledge, experience, and skills. Know-who is the ability to acquire, transform, and apply that know-how. Know-who based companies know who has the know-how; have the active empathy to rapidly establish the trustful relationship required to acquire that know-how; and have the multiple competencies required to transform and apply it in a new context so that innovation can occur. To know who has the know-how gives new opportunities for corporate entrepreneurship through exploration and creation of new knowledge and invention. Know-who can also transform the results into practical processes for global exploitation of innovation." [32]

It is worth highlighting here that the *know-who* described above has a dynamism associated with it that the single primitive *Who* does not always convey. This can partly be explained by the legacy of the library in traditional approaches to cataloguing publications, where *Who* (e.g., Author) is commonly clustered with *What* (e.g., Title), *When* (date of publication), and *Where* (place of publication). The positioning of know-who with know-how, then, represents a significant shift from this.

Arguably more significant than either *How* or *If* are *Why* questions. This is because while serving the important function of helping "make sense" of things, answers to such questions typically demand an explanatory narrative – a rationale. Unlike the more objective primitives of information discovery it is typically the case that a 'definitive' answer is not achievable but rather a range of explanations. It is also of interest that a *Why* question within a scientific discipline of study (e.g., *Why does salted water boil at a higher temperature than pure water?*) more readily provides an "answer" than do questions pertaining to political history (*Why are the Israelis and Palestinians at war?*). Perhaps more significant, though, is that analysis so far reveals that *Why* questions are not always considered in practice! The question then becomes: *Why?*

4. Conclusions and Future Work

Over the last decade ICT applications developed to support learning and knowledge management have moved through a number of phases. Some of this innovation has been enabled by standards In the majority of cases these applications have been developed to facilitate and/or manage access to *learning content* and to support and develop *communications* associated with learning and knowledge sharing. A smaller proportion of applications have been focused on supporting teaching and learning *activities* and *workflows* associated with knowledge sharing and management. Analysis suggests that despite the proliferation of applications there exists a broad frontier in terms of ICT innovation that might facilitate deep learning and holistic implementations of KM – in particular, designs and implementations that support the primitive question of *Why* in making sense of things.

In this paper the InterCog Sense-Making Model has been presented to help distill and explain the relationships between networks, metadata, e-learning and knowledge management. These relationships must be understood in order to inform and underpin future development of ICT infrastructure and services relevant to e-learning and knowledge management.

A key objective for future work will be to test the working hypothesis associated with the "primitives" of learning and knowing and to determine whether analysis of "answers" associated with *Why* questions might yield structures and patterns (in terms of secondary and tertiary pathways of investigation) as the most preferred or viable. If so, then it is anticipated that these findings might then inform the development of rich scaffolding to enable learners to probe deeper into a subject domain while engaging in e-learning.

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