# Context and Metadata
# for Learning, Education, and Training

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**Abstract**

This chapter highlights the issue of *context* in determining what might best inform the next generation of metadata schema that will in turn best support learning, education and training. Context can be understood as a critical component in the value-chain that renders data and information into knowledge. It is also multi-faceted and can be viewed through many lenses – such as social, historical, academic, vocational, computational, etc. As the story of the e-learning industry evolves it has been accompanied by a growing mix of stakeholder participation in the various forums focused on interoperability specifications and standards.

Work over the last five years by groups such as the Dublin Core Metadata Initiative (DCMI), the IEEE Learning Technology Standards Committee (LTSC), and the IMS Global Learning Consortium (IMS) has resulted in standard data models that facilitate networked information discovery and retrieval while also supporting learning object management. These data models have provided critical foundations for the growing infrastructure that supports e-learning. However, in the wake of implementing systems that match user requirements, it has become apparent that the metadata story is far from over. It will prove to be a story similar to the progression from information-based (content centric) technologies toward learning- and knowledge- (context-aware) technologies. It will also be a story of harnessing the capabilities of the Internet in the pursuit of learning and knowledge sharing, a story of complex adaptive systems.

Historical perspective is useful in that it provides some sense of time and place, of circumstances and progression, of the dynamics of society and technology. In a word, historical perspective provides *context* for understanding current developments.

> “What do we know that we didn’t know ten years ago? That learning and knowledge are the result of

multiple, intertwining forces: *content, context, and community*."
(Seely Brown, in Ruggles, & Holtshouse, 1999, p. ix)

It is hardly over-stating things, then, to muse that in just a few short years the World Wide Web has assumed a pivotal role for an ever-increasing number of stakeholders actively involved in learning, education, or training. There are many factors that have contributed to this situation. Included among them: research and development of key technologies that promote interoperability of content and applications (such as XML); increased capacity of telecommunications infrastructure; the 'rise of the network society' (Castells, 1996); and, an international effort aimed at developing technical standards and protocols to facilitate e-learning.

Of course, it is also somewhat sobering to consider that in those few short years we have also witnessed the bursting of the expectations bubble that drove the *dot com* investment boom of the late twentieth century. Among the casualties were some well-resourced institutions and consortia focused on being first-to-market in delivering innovative e-learning products and services (Ryan, & Steadman, 2001). Such boom and bust scenarios have always characterised the dynamics of the stock market. However, we should guard against making premature assessments as to the emerging e-learning industry itself based upon such data and events. Why? Because if the development of standards is understood to be an indicator of market maturity and stakeholder commitment (as it conventionally is), then we can safely say that in this initial boom and bust no such standards were yet developed!

While there existed earlier efforts (e.g., initiated by the Aviation Industry Computer-based-training Committee) standardisation in the area of (online) learning technology began to seriously move forward from around 1997, through the IEEE Learning Technology Standards Committee (LTSC). Arguably one of the most significant developments to take place since this time has been the standardisation by the IEEE of Learning Object Metadata

(LOM, 2002). It has been significant because it is a foundation from which other e-learning industry specifications are forming. It has also been significant because it represents the first signs of maturation of e-learning standardisation. And it is no accident that this standard is concerned with metadata, for metadata is a key feature of structured information.

Librarians and archivists have been routinely concerned with metadata almost from the day their industries began – through tasks such as classification, indexing, record-keeping, and information management enabling information retrieval and resource discovery. With the birth of the Web, then, it is no surprise that the Dublin Core Metadata Initiative soon got underway. Its major contribution, pre-dating the IEEE LOM by only a few years, has been the development of a simple data model that distills the main metadata requirements of librarians and archivists and it is designed to facilitate networked information discovery and retrieval at a generic, cross-domain level. Within this background context the following discussion considers issues concerning aspects of structured information, the modeling of context, and how context might be better used through metadata in learning, education and training.

**Organising Information**

Information can be organised in a multiplicity of ways:

- Hierarchically structured, based upon authoritative classifications and taxonomies (such as the Library of Congress Subject Headings or Dewey Decimal Codes);
- In enterprise databases (such as a contacts listing);
- Associatively (via hyperlinks on the Web); or even
- In a pile of papers chaotically assembled on an office desktop or floor.

While some methods may be more persistent over time than others (such as structured library catalogues), in each case *relationships* can be imputed to exist between discrete information resources. Structure and relation can therefore be seen as two sides of the one coin and are key organising principles for making sense from information. The ‘entity-relationship’ model has thus become an important conceptual foundation for the W3C-led initiative on the Resource Description Framework (RDF) (Miller, 1998). It may yet prove to be even more profound as further coalescence between heterogeneous networks (social, technical, informational) evolves.

In the development of technical specifications, it has become standard practice – certainly within organisations such as the IMS Global Learning Consortium – to begin with articulating use-cases in the requirements gathering phase. Such use-cases convey both a sense of flow and a sense of context. Once a suite of requirements is gathered then the next step is to develop an *information model* or *data model*. Without such modelling, technical specifications for the design of information systems or systems that support learning are of dubious value. As Heimbürger suggests:

> “Modelling is needed to understand, explain, organise, predict, and reason on information. It also helps to master the role and functions of components of information systems.” (Heimbürger, 2002)

From an entirely different perspective based upon a ‘sense-making’ methodology that also contests the ‘innocence’ or ‘neutrality’ of information, Dervin (1998, 2001) introduces the notion of the early twenty-first century as a “dialogic era”. A dialogic era is a time (and place) configured more as an interplay of coincident polarities, an era that has moved beyond the struggle of modernity versus post-modernity. In developing this idea she suggests that the ‘innocence’ of information is humbled if some basic premises regarding its formation and veracity are considered:

> “One of these premises is that human beings make and unmake information in times and spaces, in dialogue. The second is that information is made despite and at the same time in human fallibilities. The

> third is that information can capture at best only a portion of reality for there is inherent discontinuity in reality itself. The combination of these three ideas suggests that all knowledge is inherently fallible and must be humbled to the time and place and procedurings of its origins." (Dervin, 2001, p. 5)

A complex state of affairs, especially for knowledge workers! Of course, when Dervin's analysis is applied back on her own conceptual frameworks then the *discontinuities* inherent in reality must be also coincident with the *continuities*. A metaphor for this situation is that much of the digital information we process we also typically experience as analogue and continuous. Analyses such as Dervin's are important in achieving authenticity of our information models and compare well with Wenger's (1998) notion of 'duality' that is used to describe the interplay of explicit and implicit knowledge.

Such an abstraction may at first reading seem philosophical but when considered further it can be seen as strongly pragmatic. We live in a world (or worlds) of relativity – there is not one classification system or one analysis that we all subscribe to. As Shabajee suggests: "Any object, physical or virtual, could be described and discussed in possibly limitless ways" (Shabajee, 2002). It is no wonder, then, that we are confronted with the problem of having to develop sophisticated communications systems that can facilitate the interoperation of different schema.

**Why Metadata?**

So how does metadata help? In terms of organising digital information there are arguably three main kinds of metadata that can be pragmatically applied: descriptive, administrative, and structural – particularly if one is primarily concerned with describing and managing *content*. Depending on the classification scheme many more specific functions of metadata can be discerned, although it is debatable whether these functions can be regarded as unique high-level categories in themselves. Examples would include metadata that carries information about technical aspects, intellectual property, or preservation aspects of a resource or domain-specific metadata such as that which carries educational information.

Given the proliferation and wide-ranging functions of metadata schema the Digital Library Federation released in 2002 a specification for encoding metadata that would facilitate interoperability between digital objects and libraries. Known as METS, the Metadata Encoding Transmission Standard presents a five-layer schema that includes descriptive, administrative, and structural metadata together with two other key layers: ‘file groups’ (all the sub-files that might comprise a digital object); and ‘behaviours’ (information concerning run-time behaviours that might be associated with particular content) (METS, 2002). This model has many structural similarities to the IMS *Content Packaging* specification (IMS CP, 2002).

Many of us may be quite familiar with descriptive (e.g., ‘subject’ and ‘keywords’) and administrative (e.g., ‘last updated’) metadata but it is likely that structural metadata requires some further explanation. This is summarised well from the METS documentation:

> “The metadata necessary for successful management and use of digital objects is both more extensive than and different from the metadata used for managing collections of printed works and other physical materials. While a library may record descriptive metadata regarding a book in its collection, the book will not dissolve into a series of unconnected pages if the library fails to record structural metadata regarding the book’s organization, nor will scholars be able to evaluate the book’s worth if the library fails to note that the book was produced using a Ryobi offset press. The same cannot be said for a digital version of the same book. Without structural metadata, the page

> image or text files comprising the digital work are of little use…" (METS, 2002, p. 1)

The IMS Content Packaging specification provides this kind of information within a specific context: the exchange of e-learning content between applications such as Learning Management Systems where the content is typically an aggregation of learning objects. But a 'content package' is not complete if it has no metadata. In this sense, metadata can be understood as providing context (such as relations between learning objects in the package to each other or rules that might specify when a file must be launched).

It follows, then, that most metadata arguably provides some sense of context about the data or information it describes. This is true even for minimalist (proposed) metadata formats or "kernels" such as the Electronic Resource Citation (ERC) where compactness and ease are aimed for in four simple statements describing 'who', what', 'when', and 'where' (Kunze, 2001). As the discussion later in this chapter argues, each of these four information placeholders provides contextual perspective.

## Content for some – Metadata for others

In modelling the functional components that were needed to develop the IMS Global Learning Consortium's Digital Repository Interoperability specification (IMS DRI, 2003) it proved to be pragmatic to identify 'digital assets' or 'content' as one entity and 'metadata' (that describes those assets) as another. However, while such models help to identify systems interactions it is also true that such models can mask deeper complexity. For example, in the case of a repository designed to broker resource discovery, the 'assets' it gathers into a collection might only be metadata records. Thus, *one person's (or service's) metadata may be another's content*. The complexity of this relationship is summarised in Figure 1, which is a representation of relationships in the digital domain, where there is always recursive potential between data, information, and knowledge.


Figure 1. Relationships of the digital domain

In a similar way it can be argued that while content and context can be modelled as separate entities and are commonly understood as separate they are often experienced as fused, or as having ambiguous boundaries. Moreover, where context is encoded as a discrete information resource it therefore assumes an operational function in much the same way as content. One person's context may be another's content. And one person's knowledge will likely be another's information. Of course, this does not mean that ambiguous models are needed. To the contrary, it may be that through a disciplined separation of content and context, as advocated by Naeve (2001a) and his colleagues (Nilsson, Palmer, & Naeve, 2002), that interesting innovations in online interaction will take place. The development of their *Concept Browser*, a tool designed to navigate their *Knowledge Manifold* (Naeve, 2001b), includes

> "a strict separation of *context* and *content*, contextual
> descriptions in terms of a collection of semantically
> visual context maps, which can be navigated by
> moving through *contextual neighborhood*s,
> presentation of the content components through

> context-dependent *aspect-filter*s, and *contextualization* of content components that are themselves context maps." (Naeve, 2001a, p. 1)

Such issues of the separation of content and context in information modelling can be seen as important, not only for managing educational resources for learning and training, but also for managing workflow within knowledge management systems. But, before delving further into that topic let's take a step back and consider context in more detail.

## What is Context?

Like beauty, context is discovered through the eye of the beholder – a user's perspective is what ultimately counts when defining context. With this caveat in mind the following discussion is aimed at examining how context might impact the development of metadata schema and other tools designed to support learning, education, and training.

> "Contextual information is that extra, associated, related, assumed and perhaps *a priori* information or knowledge that is required to meaningfully interpret the content of any given information source."
> (McCarthy, 2000, p. 1)

McCarthy's definition comes from an archival or cultural informatics perspective where issues of provenance (origins) of a resource are pre-eminent. As such, descriptions of the person or creator of a resource are as important, if not more so, than the 'resource' itself. This emphasis can be seen as an attempt to apply rigor to the processes of constructing meaning from documents and objects through the assignment of cultural (time and place) context. And again, implicit in such a perspective is the role of relationship – information in relation to other information, data, knowledge, or understanding.

Thus, for archivists, a primary function is the documentation and preservation of ‘records in context’ (McCarthy, 2000). But why should just the archivists be concerned by such matters? Surely these issues must be of importance to any educator concerned with authentic enquiry and an appreciation for human history. Such perspective should also be of concern for those interested in information infrastructure that persists over medium- to long-term time horizons. If such issues are not attended to, then it may yet prove to be a grand irony that while the Internet may survive a nuclear holocaust it may not survive the revolutions in information technology. For example, many scenarios may flourish where public trust loses ground to suspicion and quality assured information is challenged by new forms of disruptive corporate espionage or media norms (O’Neill, 2002).

In responding to this challenge the cultural informatics community is developing Encoded Archival Context (EAC, 2002) as an archival standard (in XML) through an international collaboration. EAC extends the current capability of Encoded Archival Description (EAD) and will enable encoding of discrete records that carry information about the creators of archival materials (such as biographical details and agency histories) (Pitti, 2001). The CIDOC Documentation Standards Group is also pursuing work in this area through development of a common conceptual reference model for documentation (CIDOC, 2003).

But for archivists and non-archivists alike, context also helps establish things like authenticity, quality, authority, and credibility. A book published by MIT Press, for example, will typically be recognised as having more credibility than, say, the British tabloid press. Related to this function of context is the notion of ‘truth’. While ‘truth’ is not a necessary requirement in sense-making (because patterns within data sets and information help establish meaning and narrative through interpretation) in determining the truth or otherwise of assertions, statements, or documents, it is sometimes crucial that the context in which such things were made is also known. To illustrate this with an educational example, we may be tempted to accept as true the geometric assertion that the aggregate angles of a triangle will always equal 180°. However, while this is true for two-dimensional plane geometry it's not necessarily true in other geometries, such as the surface of a sphere or hyperbolic geometry. Following this last point it is important to emphasise that 'objectivity' in metadata creation is probably unattainable because a cataloguer still makes indexing *choices*, even if they are informed.

### Context and Learning

When considering how context is important – and *what it is* – in learning, education, and training, added to McCarthy's definition above should also be information about *how, when, where,* and even *if* the information might be *applied*. Given that knowledge can be characterised as having a dynamic dimension that is not intrinsic to information alone – setting it apart from information – then another way of saying this is that *know-how, know-when, know-where,* and *know-if* are possible applications of educational resources (Norris, Mason, & Lefrere, 2003). Indeed, such facets of knowing are prime candidates for encoding as educational resources.

*Application* is a keyword here. When 'information resources' are indexed or catalogued they may be assigned a range of contextual information (such as the simply conceived ERC format of who, what, where, when) but it is typically the case that the metadata that is applied is largely concerned with 'aboutness', or *know-what*. Thus, in its inaugural meeting in 1999 the DCMI DC-Education Working Group clearly identified *'teaching methods'* and *'learning activities'* as important information that could be used to enhance the descriptiveness and utility of online educational resources. However, due to a range of factors such as the complexity involved in producing a schema DC-Education has not yet produced substantive work in this area (DC-Ed, 2003).

### Learning and Knowing

Figure 1 is also intended to convey the complexity of the relationships between entities (such as data, information, and knowledge) in the context of learning, education, and training. The METS standard clearly identifies *behaviour* as an aspect of a resource, either intrinsic or potential. The IMS

*Simple Sequencing* specification also deals with such information – although, to the uninitiated, the specification could hardly be regarded as 'simple' (IMS SS, 2003). The key point here is that there are many complex issues that need to be addressed, when data models and information models (and, for argument completeness, knowledge models) are developed to be applicable in learning, educational, and training contexts,. For example, while an interaction in the digital domain can be logged and subject to systems analysis, certain judgment calls are made if such interactions are modeled as components of learning and knowing. Not only are '*learn*', '*know*', '*reflect*' verbs but such actions are always shaped by context. Thus, in harnessing the capabilities of the Internet in the pursuit of learning and knowledge sharing, it seems there is a fundamental requirement in modeling learning, educating, and training as complex adaptive systems (Jaworsky, 1996).

When Lave and Wenger (1991) coined the term 'communities of practice' they argued that learning and knowledge sharing are typically informal and highly conditional upon context. Their views have since had a significant impact upon learning theory – in particular, constructivism (Jaworsky, 1996). More recently, Wenger has defined *learning* as "the engine of practice, and practice is the history of that learning" (Wenger, 1998, p. 96). Such a recursive description has important implications for the design of online systems that are intended to support e-learning as well as knowledge management. How will such systems facilitate the reflective learning required in coming to grips with 'histories of learning'?

In teaching and learning, context plays an important role in developing critical thinking and discernment skills. Constructivism, as an important pedagogical theory, emphasises the construction of meaning through *sense-making* as pivotal in the learning process. Thus, as Barbara Jaworsky distils it

> "knowing is an action participated in by the learner.
> Knowledge is not received from an external source . . .
> Learning is a process of comparing new experience
> with knowledge constructed from previous experience,

resulting in the reinforcing or adaptation of that knowledge"
(Jaworsky, 1996, p. 7).

**Describing Educational Resources**

From another perspective Shabajee (2002) describes a 'fundamental dilemma' that confronts developers of educational resource repositories and online resource discovery services. In the politics and confusion of early adoption, however, various stakeholder groups have sometimes missed the significance of this dilemma. So what is it? In simple terms it has to do with a tension between *generality* and *specificity* of description, and it arises from the parallel standardization efforts of various metadata initiatives – such as IEEE LOM and DCMI. While both initiatives have explicitly pursued standardization of data models that promote interoperability, their purposes have been differently conceived. For the IEEE LOM the interest has always been in providing a richly conceived model that can express specific, granular descriptions of resources (learning objects) that have been purposed for learning (as 'learning objects'). Such specific metadata is also defined to enable the run-time management of learning objects within applications.

For DCMI, the main purpose has always been facilitating cross-domain resource discovery – that is, discovery of information on the Web that has not necessarily been purposed for learning. Thus, while it is true that a generally described resource may be discoverable and then purposed for learning, a specifically described resource is typically only discoverable within applications that are similarly specified. Conversely, a resource that is described for a precise purpose is likely to be better suited to that purpose than one that is closely related (Ip, Morrison, Currie, & Mason, 2000). In other words, metadata can derive its utility from both ambiguity and precision.

An instance of the dilemma can be seen in the assignment of 'audience' information as an attribute of a resource. For example, while a resource might be specifically developed for teachers, tagging it so that *only* teachers can discover it may not yield the full usefulness of that resource. In Shabajee's words:

> "developers are unlikely to want (or be able) to restrictively specify who their users should be and, in particular, how they *should* use individual assets in their particular educational contexts ...[however] they must make decisions about what metadata terms to choose to describe their assets."
> (Shabajee, 2002, p. 1)

The issue of 'audience' has historically been the subject of many debates within the DCMI. On the one side are advocates of a 'sixteenth' element being added to the core element set. On the other side are advocates of a strict dividing line between descriptions concerning 'aboutness' of a resource and descriptions of 'usage' (how the resource might be used) or 'audience' (who might use it).

In late 1999 the DCMI formed its first domain-specific working group, the DC Education Working Group, with an initial scope of work broadly defined to make recommendations about extensions and/or 'qualifiers' that would assist in describing educational resources. It became clear very soon that for stakeholders in educational settings some facets of audience (such as user level) can be important and even intrinsic attributes of an educational resource (Sutton and Mason, 2001).

**Context and LOM**

Having established the conceptual framework of this discussion it is now worthwhile to consider the *one* industry standard that has been developed to support metadata application to educational resources, the IEEE LOM.

> "The purpose of this Standard is to facilitate search, evaluation, acquisition, and use of learning objects, for

> instance by learners or instructors or automated software processes. The purpose is also to facilitate the sharing and exchange of learning objects, by enabling the development of catalogs and inventories *while taking into account the diversity of cultural and lingual contexts* [my italics] in which the learning objects and their metadata will be exploited."
> (IEEE, 2002, p. 5)

Within the LOM data model, 'context' has two main semantic usages:

1. Context is used in an explanatory way – for example, within data element *5.3: Educational Interactivity Level – "The degree of interactivity characterizing this learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behavior of the learning object. … NOTE 1:- Inherently, this scale is meaningful within the context of a community of practice."* (IEEE 2002, p. 25)
2. As data element *5.6:Educational Context – "The principal environment within which the learning and use of this learning object is intended to take place."* (IEEE 2002, p. 28) And thus, the permitted values include 'school, higher education, training, other'.

Again, historical perspective is useful in considering this standard – it took close to five years of collaborative effort to formalise. However, its origins were at a time when 'content' was considered 'king' and object models were in the ascendancy. While the LOM data model attempts to do justice to context issues – and in many ways LOM is designed to enable the versatile application of learning objects in a range of different contexts – an argument can be sustained that it is still a content-centric model, or perhaps a *content view on context*. After all, consider the morphology of the term 'learning object': *object* is a noun and *learning* an adjective. Systems, such as Learning Management Systems, that utilise these objects may be configured to support *activities* such as learning processes but ultimately the learning objects are managed as *content*. And systems that are designed to manage learning objects are commonly referred to as Learning Content Management Systems.

There follows, then, another argument that the extraction of context from content together with independent modelling and development of context information may provide a high value-add to the development, access, and application of online educational resources. These may be represented as either ‘context objects’ or rules that might apply when triggered by certain events.

**W3C Technologies**

The preceding discussion is, of course, largely theoretical. Where the real acid test takes place – after the refinement of information models – is in the development of technology that not only works but triggers stakeholder adoption. Within the wide scope of the research and development conducted by the World Wide Web Consortium there are two key technologies that have succeeded in gaining widespread attention: XML (Extensible Markup Language) and RDF (Resource Description Framework). Of course, it is the former that has succeeded in the marketplace, while the latter remains very much in the realm of a ‘promising technology’, it being the foundation for the Semantic Web initiative. It is promising, because it provides a means for the machine parsing of structured metadata that carries ‘meaning’, the parsing of semantics, not just syntax. RDF-based encoding thus provides a method involving not just connected *documents* but also connected *statements*. From an RDF perspective hierarchical taxonomies are tempered by relational ontologies. In other words, RDF explicitly models the relativity of all semantics while providing a framework for closer meshing of related semantics – and sense-making from semantics are ultimately revealed.

In responding to the kinds of challenges that arise when context is considered as having potential for independent modelling some innovative research and development has been undertaken by Mikael Nilsson and his colleagues at the Swedish Royal Institute of Technology. Through exploring the potential application of RDF in peer-to-peer applications their work may yield new practical ways in developing and managing metadata for educational resources while accommodating a richer application of context than current tools allow (Nilsson, Palmer, & Nave, 2002). Certainly, in the development of an RDF binding to the LOM data model Nilsson's work has revealed a number of interesting issues (Nilsson, 2003).

## Conclusion

A range of methods can be currently discerned where the development of metadata for educational resources is concerned. These range from the application of metadata to purposed learning resources to the application of educational contexts to information resources not necessarily originally purposed for learning. The standardisation of the IEEE LOM can be regarded as a significant milestone in an ongoing effort to make educational resources accessible.

In proposing a way forward, *context* has been identified as a candidate for independent modelling from content – as either 'context objects' or rules that might apply when triggered by certain events. Such an approach may provide a high value-add to the development, access, and application of online educational resources.

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