Proc. Int. Conf. on Dublin Core and Metadata for e-Communities 2002: 63-69
© Firenze University Press

Building Educational Metadata Application Profiles

Norm Friesen
Athabasca University
norm@netera.ca

Jon Mason
education.au limited
jmason@educationau.edu.au

Nigel Ward
education.au limited
nigel@thelearningfederation.edu.au

Abstract

Metadata schemas relevant to online education and training have recently achieved the milestone of formal standardization. Efforts are currently underway to bring these abstract models and theoretical constructs to concrete realization in the context of communities of practice. One of the primary challenges faced by these efforts has been to balance or reconcile local requirements with those presented by domain-specific and cross-domain interoperability. This paper describes these and other issues associated with the development and implementation of metadata application profiles. In particular, it provides an overview of metadata implementations for managing and distributing Learning Objects and the practical issues that have emerged so far in this domain. The discussion is informed by examples from two national education and training communities – Australia and Canada.
Keywords: *application profile, educational metadata, interoperability, CanCore, LOM, Learning Federation.*

1. Introduction

With the recent approval of the Learning Object Metadata (LOM) data model as a standard by the IEEE (IEEE 2002) and of Dublin Core's status as a NISO standard (DCMI 2001), metadata models have achieved a stability and level of community commitment requisite to their implementation in the form of application profiles and supporting infrastructure. The consensus represented and codified in these standards provides implementers and developers with a solid foundation for creating metadata infrastructures to meet the needs of national, regional and local educators and learners. Given the necessarily abstract nature of these standards, the task of adapting them to meet the specific and concrete needs of these stakeholders requires interpretation, elaboration, extension, and in some cases, the simplification of their syntax and semantics.

The DCMI and LOM communities started addressing these issues via a shared workplan outlined in the Ottawa Communiqué (Ottawa 2001). In accordance with this plan, these communities subsequently released the important "Metadata Principles and Practicalities" paper (Duval et al. 2002), which emphasized that this work of adaptation is best undertaken through the definition of application profiles:

> An application profile is an assemblage of metadata elements selected from one or more metadata schemas and combined in a compound schema. Application profiles provide the means to express principles of modularity and extensibility. The purpose of an application profile is to adapt or combine existing schemas into a package that is tailored to the functional requirements of a particular application, while retaining interoperability with the original base schemas. (Duval et al. 2002).

However, it is our common experience that the challenge of retaining interoperability with "original base schemas" – and with other related application profiles – is a non-trivial matter. Both adaptation and interpretation play important roles in the process of profiling metadata for the needs of particular projects and communities. As this paper will illustrate, these needs and requirements are also shaped in complex and subtle but significant ways by the policy

OPEN ACCESS
This article is licensed under a **Creative Commons Attribution 4.0 International License**, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.
https://doi.org/10.23106/dcmi.952106953

and cultural environments in which these projects and communities exist.

The discussion that follows is largely focused on the development of two application profiles:

1) The Le@rning Federation Application Profile (TLF 2002), which combines elements from LOM, Open Digital Rights Language, and accessibility statements; and
2) CanCore (CanCore 2002), a subset of LOM elements, focusing on best practices for element and vocabulary semantics.

Both the Australian and Canadian profiles have been developed in response to unique sets of goals and requirements. Although both profiles emerge primarily from activities in the public education sector, the substantial differences separating these sectors in Australia and Canada – as well as a number of other factors – has resulted in significant differences in emphasis.

Despite these differences, these two profiles demonstrate surprising commonality in terms of their guiding principles and underlying assumptions. The authors hope that this commonality might also inform future work for DC-Education.

The metadata infrastructure under development in both the Australian and Canadian communities is presented in summary form. This is followed by an overview of important practical issues addressed by the projects during creation of their metadata application profiles. An example of how each profile has integrated the work of both the Dublin Core and IEEE LOM communities will be provided. Finally, the fundamental, underlying similarities between the profiles are highlighted.

2. The Le@rning Federation Application Context

The Le@rning Federation (TLF) is a five year initiative aimed at developing a shared national pool of quality online learning content for Australian schools within a framework that facilitates distributed access. It has been co-funded within a policy context developed in collaboration between the Australian Commonwealth government and State and Territory education authorities and focused on the strategic importance of fostering online culture in school education.

In context of this collaborative framework, metadata plays a pivotal role. It is required to support the access, search, selection, use, trade and management of Learning Objects. The Le@rning Federation has addressed its metadata requirements through the development of an application profile that combines or references a number of metadata schemes or namespaces.

Development of TLF metadata has been primarily guided by principles of interoperability and pragmatism. The project recognised that adoption of international metadata standards was critical for achieving interoperability between software used to create, manage, distribute, and use learning objects. It also recognised that adoption of metadata standards should not compromise the ability of school education systems and sectors to achieve their own educational priorities. Working within the tensions between adoption of international and national standards and the pragmatic solutions required for The Le@rning Federation has been a challenging and exciting aspect of the project.

A key shared perspective of the Australian k-12 authorities has been the recognition that optimisation of the *learning value* of digital Learning Objects is fundamental in establishing interoperable metadata specifications for TLF. In other words, it is important for the technology to accommodate learning outcomes and curriculum frameworks, rather than requiring these frameworks to be adapted to technical requirements and limitations. Online content in TLF is being designed and developed in the form of Learning Objects that can be deployed in multiple settings. TLF defines Learning Objects as components of online content (animations, video clips, texts, URLs or sequences of such assets) that have educational *integrity*. That is, they possess educational value independent of any one application or context. Learning Objects with educational integrity can be identified, tracked, referenced, aggregated, disaggregated, used and reused for a variety of learning purposes. Such Learning Objects are developed to function both as discrete entities and as aggregate objects contributing to the achievement of particular learning outcomes.

Schools will access TLF online educational content within a framework of distributed access to State and Territory gateways. TLF will provide access to online educational content via a repository called the 'Exchange'. Education systems will retrieve online educational content from the Exchange and distribute Learning Objects through their online systems. The education systems will also provide Learning Object manipulation tools and e-learning environments required by schools.

It is also important to highlight a broader context. With regard to the application of metadata for educational purposes EdNA (Education Network Australia) developed its first (DC-based) schema for the purposes of resource discovery in 1998. At the time, this represented a hard-won consensus among state and territorial education authorities. However, as both internal requirements and international e-learning specifications developed and changed the importance of referencing work done by others (such as the IMS Global Learning Consortium) while also leveraging work already done in EdNA became increasingly clear. It also became clear that managing learning objects would require metadata for functions other than discovery (i.e. requiring reference to the LOM along with other metadata specifications).

OPEN ACCESS This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.
https://doi.org/10.23106/dcmi.952106953

3. Le@rning Federation Profile Overview

TLF metadata application profile has been developed in recognition of the fact that existing metadata element sets met some of TLF requirements, but no single element set would be capable of meeting them all. Consequently, The Le@rning Federation Metadata Application Profile (TLF 2002) has taken elements from different metadata specifications or namespaces:

- Dublin Core Metadata Element Set, v1.1 (DCMES 1999);
- Dublin Core Qualifiers, (2000-07-11) (DCQ 2000);
- EdNA Metadata Standard, v1.1 (EdNA 2000); and
- IEEE Learning Object Metadata Standard, draft v6.4 (IEEE LOM 2002).

Some TLF requirements were not met by any standard. For this reason, TLF has also defined new metadata elements. All of the elements comprising TLF metadata are grouped into five categories:

The **management** category groups the information related to both the management and discovery of the digital asset as a whole. It contains some common descriptive elements as well as lifecycle and contribution information

The **technical** category groups the technical requirements and characteristics of the digital asset. For example, it contains information on the file types, software and hardware requirements of the digital asset.

The **educational** category supports description of the educational integrity of a Learning Object and includes elements for describing:

- the object's curriculum topic;
- the potential learning outcomes supported by the object;
- teaching methods for presenting the material; and,
- the intended audience for the object.

The **rights** category groups the intellectual property rights and conditions of use of the digital assets. To place a pool of legally reusable educational material within the reach of all Australian students and teachers requires it to be managed in a way that negotiates and provides agreed reimbursement to owners of intellectual property and that facilitates the creation, trade and usage of online content. To achieve this, TLF curriculum content will need to meet relevant statutory and contractual obligations. TLF metadata contains support for digital rights management by including both text and Open Digital Rights Language (ODRL) statements (ODRL 2002).

The **accessibility** category incorporates an Accessibility Specification developed by the TLF that conforms to Commonwealth laws concerning accessibility. The Specification aims to ensure that online resources and services are inclusive of a range of teaching and learning capacities, contexts and environments. It affirms policy commitments by State and Territory education systems to *inclusive* educational provision. TLF metadata contains support for describing the accessibility of Learning Objects in terms of W3C Web Accessibility Checkpoints and TLF-defined learner accessibility profiles.

4. CanCore Profile Context

In contrast to many application-profiling activities, the CanCore Learning Object Metadata Application Profile (or simply CanCore) was *not* developed in response to any single project or undertaking. Instead, this profiling initiative was established in November 2000 to address asset management and resource discovery issues common to a number of e-learning projects sponsored by both federal and provincial governments. These include:

- the BELLE (Broadband-Enabled Lifelong Learning Environment) project, a $3.4 million shared-cost initiave funded under the federal government's Industry Canada department. BELLE's objective has been to develop a prototype educational object repository.
- the POOL (Portal for Online Objects for Learning) project, a Pan-Canadian effort also funded primarily by Industry Canada. This initiative has been developing a distributed learning content management infrastructure based on a peer-to-peer architecture.
- CAREO (Campus Alberta Repository of Educational Objects), a project supported by provincial (Albertan) sources and by Industry Canada that has its primary goal the creation of a searchable, Web-based collection of multidisciplinary teaching materials for educators across Alberta.
- The LearnAlberta Portal, a project undertaken by the department of education in the province of Alberta to provide modular, reusable learning resources integrated with provincial k-12 curricula and objectives.

It is worth noting that these projects span both the higher education and k-12 educational domains, with some focusing on the needs of a single province, and others addressing the requirements of users across all the Canadian provinces and territories. A similar heterogeneity is reflected in the institutions which have hosted and otherwise supported CanCore profiling activity. These include TeleEducation, an arm of the New Brunswick provincial government, the Electronic Text Centre at the University of New Brunswick, as well as the University of Alberta, and Athabasca University.

The support of CanCore by such a broad variety of institutions and projects reflects the shared commitment of these organizations to common set of needs and requirements. Many of these shared requirements are shaped by the highly decentralized nature

OPEN ACCESS

This article is licensed under a **Creative Commons Attribution 4.0 International License**, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.

https://doi.org/10.23106/dcmi.952106953

of Canadian educational policy. Education in Canada falls under exclusively provincial and territorial jurisdiction. Besides forbidding any federal involvement in education administration or delivery, Canadian policy also encourages education to reflect and sustain a multiplicity of languages and cultures — extending well beyond English and French to include aboriginal, Slavic, Asian and other languages and cultures. (Such policies are, in part, responsible for the diversity of projects listed above, and are perhaps also reflected in these projects' emphasis on infrastructure rather than content).

While explicitly requiring a diversity of educational contents and administrative structures, such an environment also has the effect of defining a common set of values and concerns for those developing educational technologies in Canada. Within this context, means of ensuring cultural and linguistic neutrality and adaptability are understood as mandated requirements rather than being perceived simply as desirable virtues. At the same time, these values and concerns are informed by an acute awareness of Canada's relatively small size as a market for content and Internet technologies, as well as its proximity to the world's largest purveyor of these and other commodities. Together, these factors provide a strong inducement for collaboration and cooperation to protect interests of diversity and adaptability. It is therefore not surprising that CanCore was initiated by the projects mentioned above "to ensure that educational metadata and resources can be shared easily among its users as effectively as possible with others across the country" (Friesen et al. 2002).

5. CanCore Profile Overview

Given the diversity of projects and players behind the creation of CanCore, it seems natural that this metadata initiative would focus on bringing these stakeholders together under the banner of a single consensual artefact. This artefact is represented by what is now the IEEE LOM standard; and the CanCore initiative began by identifying a subset of LOM elements that would be of greatest utility for interchange and interoperation in the context of a distributed, national repository infrastructure. The CanCore element set is explicitly based on the elements and the hierarchical structure of the IEEE LOM, but CanCore has sought to significantly reduce the complexity and ambiguity of this specification. In keeping with this approach, CanCore has developed extensive normative interpretations and explications of the metadata elements and vocabulary terms included in its "consensual subset" of LOM elements. This work of interpretation and simplification is featured in the CanCore Learning Object Metadata Guidelines (Fisher et al. 2002), a 175-page document distributed at no cost from the CanCore Website.

In this work, CanCore can be seen to take its cue from a definition of application profiles that precedes ones more recently referenced. Instead of "mixing and matching" elements from multiple schemas and namespaces (Heery, Patel 2002), it presents "customisation" of a single "standard" to address the specific needs of "particular communities of implementers with common applications requirements" (Lynch 1997).

The CanCore application profile comprises some 36 "active" or "leaf" IEEE LOM elements. These elements were chosen on the basis of their likely utility for interchange and interoperation in the context of a distributed, national repository infrastructure. Compared to the elements comprising TLF, the CanCore elements are focused fairly exclusively on resource discovery. Those dealing with rights management and educational applications are kept to an effective to a minimum. This emphasis on resource discovery might also be understood as a result of the heterogeneity of the community CanCore is serving. For example, to accommodate the diverse curriculum and learning outcomes schemes and hierarchies developed separately for k-12 education by each Canadian province, CanCore references and explicates the use of almost all of the LOM Classification element group. By way of contrast,, the TLF profile is able to go far beyond identifying generic placeholder elements, and specifies both specialized elements and vocabularies for learning "strands", "activities", "design" and "content/concepts". Moreover, approaches to both educational application and rights management often vary considerably even *within* the projects and jurisdictions served by CanCore. Consequently, in further contradistinction to TLF, CanCore has not sought out a role in achieving consensus or coordination between *between* Canadian projects on these matters.

6. Application Profile Implementation Issues

6.1. The Le@rning Federation: Unifying Metadata Information Models

The Le@rning Federation Metadata Specification draws elements primarily from both IEEE LOM and Dublin Core. However, these metadata schemas use different information models for defining and constraining the function of their metadata elements. Unifying these information models has thus been a challenging part of developing the application profile.

The Dublin Core elements are described with an information model based on the ISO/IEC 11179 standard for the description of data elements (ISO 11179). Each element is described using the following ten elements:

- Name – The label assigned to the data element.
- Identifier – The unique identifier assigned to the data element.

OPEN ACCESS

This article is licensed under a **Creative Commons Attribution 4.0 International License**, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.

https://doi.org/10.23106/dcmi.952106953

- Version – The version of the data element.
- Registration Authority - The entity authorised to register the data element.
- Language – The language in which the data element is specified.
- Definition – A statement that represents the concept and essential nature of the data element.
- Obligation – Indicates if the data element is required to always or sometimes be present.
- Datatype – Indicates the type of data that can be represented in the value of the data element.
- Maximum Occurrence – Indicates any limit to the repeatability of the data element.
- Comment – A remark concerning the application of the data element.

IEEE LOM uses a different set of attributes for describing its elements. Each IEEE LOM element is described using the following attributes:

- Name – The name by which the data element is referenced.
- Explanation – the definition of the data element.
- Size – The number of values allowed.
- Order – Whether the order of values is significant.
- Example – An illustrative example.
- Value space – The set of allowed values for the data element – typically in the form of a vocabulary or a reference to another value space.
- Data type – Indicates whether the values come from an IEEE LOM defined datatype.

The Le@rning Federation application profile has adopted the attributes used by Dublin Core for describing its metadata elements. To incorporate the IEEE LOM element definitions into TLF metadata, the element definitions were recast using the ISO 11179 attributes. In most cases, the mapping was obvious: IEEE Name to ISO Name, IEEE Explanation and IEEE Example to ISO Definition, IEEE Size to ISO Maximum Occurrence, IEEE Data type to ISO Datatype.

The IEEE Order attribute was abandoned because ordered elements were not a requirement for TLF application.

Information in the IEEE Value space attribute was incorporated into the ISO Datatype attribute in TLF definition. It is interesting to note that the IEEE Value space attribute corresponds closely to the Qualified Dublin Core notion of value encoding schemes. In Qualified Dublin Core, encoding schemes identify structure that aids interpretation of an element value. These schemes include controlled vocabularies and formal notations or parsing rules.

Dublin Core elements live in a “flat” space where each element directly describes the one identified resource. IEEE LOM elements, however, live in a “hierarchical” space. Some elements are aggregates of sub-elements. Aggregates do not have values directly; only data elements with no sub-elements have values directly. The sub-elements describe attributes of the aggregated element, rather than the resource directly. For example, the IEEE LOM Relation.Resource aggregation has two sub-elements: Relation.Resource.Identifier and Relation.Resource.Description. These two sub-elements describe the Relation.Resource aggregate rather than the resource being described by the metadata record as a whole.

The hierarchical structure of the IEEE LOM presents a wide range of expressive possibilities. However, such a structure is difficult to integrate with the Qualified Dublin Core notion of element refinements. Element Refinements make the meaning of an element narrower or more specific. A refined element shares the meaning of the unqualified element, but with a more restricted scope. A client that does not understand a specific element refinement term should be able to ignore the qualifier and treat the metadata value as if it were an unqualified (broader) element.

Within the Le@rning Federation application context, it was decided that the IEEE LOM Coverage element should be refined using the Dublin Core Spatial and Temporal element refinements. These element refinements were incorporated into the IEEE LOM aggregation model as sub-elements of the coverage element. This allows distinction between spatial and temporal coverage, but does not meet the Dublin Core requirement that a refinement can be treated as if it were the broader element.

6.2. CanCore: Data Model Explication and Simplification

An illustration of CanCore’s emphasis on element and vocabulary semantics is provided by its interpretation of the IEE LOM element titled “Learning Resource Type”. The discussion of this element provided in the CanCore Metadata Guidelines is also illustrative of CanCore’s reference to Dublin Core semantics and best practices as normative guides. In addition, the issues presented by this element and its associated vocabulary also provide evidence of the challenges of facilitating resource for specifically educational resources —and of the need for semantic refinement for even the most rudimentary implementation and interoperability requirements.

The IEEE LOM standard describes the Learning Resource Type element simply as “Specific kind of learning object. The most dominant kind shall be first”. The vocabulary values recommended for this element are: “Exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, and lecture. In order to provide further guidance on the meaning of these sometimes ambiguous terms, the document refers implementers to the usage histories of the Oxford English Dictionary and to existing practice: “The vocabulary terms are defined as in the OED:1989 and as used by

OPEN ACCESS

This article is licensed under a **Creative Commons Attribution 4.0 International License**, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.

https://doi.org/10.23106/dcmi.952106953

educational communities of practice". As a final clarification, the data model document also provides a mapping of this LOM element to the "DC.Type" element from the unqualified Dublin Core element set.

In its metadata guidelines document, CanCore interprets these relatively sparse and ambiguous normative indications as follows:

> [The normative information provided by the IEEE LOM] leads to 2 possible approaches, the second of which is recommended by CanCore:
>
> 1. Use the DC Type vocabulary as is (Collection, Dataset, Event, Image, Interactive Resource, Service, Software, Sound, Text), or extend it for the various media in a collection. In each case, the vocabulary is seen as designating a media type, format or genre, relatively independent of the educational purpose or application to which it is put to use. An example of an extended form of the DC recommended vocabulary is provided at http://sunsite.berkley.edu/Metadata/structuralist.html. The fact that this element is [indicated to be] equivalent to DC Type would justify this approach. However, this approach raises the question: How is this element [indicative of a learning resource type]?
> 2. Use or develop a vocabulary that addresses learning very specifically and directly, and the ways that resources can be applied for particular educational purposes. This should occur relatively independently of the actual media type that the resource represents. For example, a text document or interactive resource could be a quiz, an exercise or activity, depending on the way it is used, and the way these educational applications are defined. An example of this type of vocabulary is provided by EdNA's curriculum vocabulary: "activity", "assessment", "course curriculum/syllabus", "exemplar", "lesson plan", "online project", "training package", "unit/module".
>
> The vocabulary values [recommended in the IEEE LOM] seem to conflate these two approaches, including values that indicate media type or format (Diagram, Figure) and values indicating educational application (exam, questionnaire, self-assessment). (Fisher et al. 2002).

In the CanCore guidelines document, this discussion is followed by references to recommended vocabularies developed to designate learning resource types in the context of other projects, as well as multiple text and XML-encoded examples and technical implementation notes. Similar documentation is provided for all of the IEEE LOM elements included in the CanCore subset.

By thus combining best practices from existing data models, implementations and application profiles, and by explicating its own normative decisions, CanCore hopes to provide significant direction and assistance to those making decisions about educational metadata – whether they be administrators, implementers, metadata record creators, or developers of other application profiles. In doing so, Cancore leverages semantic consensus already developed in the Dublin Core community (and elsewhere) to promote semantic interoperability among projects referencing the IEEE LOM, and also to work toward cross-domain interoperability through mutual reference to the DC data model.

7. Application Profile Commonalities

In discussing in broad terms contexts and experiences associated with the development of our respective application profiles, some commonly identified principles have emerged. It is clear that both profiles have been developed differently, in response to the requirements of contexts. However, it is hoped that the experience of their development will inform ongoing efforts within educational communities that are developing and implementing metadata schema for resource description and management purposes.

7.1. Respecting Existing Practice for Semantic Interoperability

The development of both TLF and CanCore application profiles has been consistently informed by recognition of the importance of existing standards and best practices. In its metadata guidelines document, CanCore has utilized every available opportunity to reference established and emerging practices as a way of grounding its normative interpretations. Both TLF and CanCore further recognize that within learning technology standards communities, much effort has been expended on the development of bindings and schemas for the purposes of syntactic and systems-level interoperability, but that less attention has been paid to issues of semantic interoperability. Both TLF and CanCore recognize that this is not universally the case and that there is plenty of excellent work either already done or underway associated with semantics. For example, as illustrated above, CanCore utilizes definitions and explications found in Dublin Core itself and in work products of the broader DC community.

It is understood by both TLF and CanCore that interoperability – semantic or otherwise – is won by degrees, and often as a result of pragmatic efforts. It seems there will inevitably be a wide diversity in the communities of practice adopting metadata for application in learning, education, and training. However, it is our experience that pragmatic and open solutions are key to facilitating adoption.

OPEN ACCESS
This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.
https://doi.org/10.23106/dcmi.952106953

7.2. Interoperability and Pragmatism

While "interoperability" seems to be a shared aim of any number of e-learning projects worldwide, it is clear that achieving it happens incrementally and often as a result of very deliberate and pragmatic efforts. Ultimately, there is a wide diversity in the communities of practice adopting metadata for application in learning, education, and training and it is our experience that pragmatic solutions are key to facilitating adoption.

8. Conclusion

Stable data models, combined with clearly delineated metadata community principles and practicalities, have facilitated development and implementation of both The Le@rning Federation and CanCore metadata application profiles. The experience of developing these two profiles has underscored the importance of identifying and responding to local requirements while at the same time respecting broader interoperability requirements. Of course, the true effectiveness of these application profiles will be tested when mechanisms for sharing or exchanging learning resources are put in place. It seems likely that further refinement of and reference between The Le@rning Federation metadata, CanCore, and other application profiles will be necessary in order for them to meet the needs of their stakeholders and of broader, cross-domain.interoperability requirements.

It is our shared view that continued and expanded dialogue on this topic would be greatly beneficial. In addition, learning resource metadata exchange testbeds and other test bed efforts would greatly enhance the interests of interoperability and resource sharing generally. Discussions regarding such collaboration between Australian and Canadian education authorities are already underway. It would be timely if similar efforts were undertaken across other domains and jurisdictions in the e-learning world. Although such work will no doubt presents daunting challenges, it is now urgently needed to realize the vision of interoperable and effective resource sharing.

References

Australian Government, 2001. Backing Australia's Ability: Innovation Action Plan
http://backingaus.innovation.gov.au/

Duval, E., Hodgins, W., Sutton, S., Weibel, S.L., 2002. Metadata Principles and Practicalities. D-Lib Magazine, 8 (4).
http://www.dlib.org/dlib/april02/weibel/04weibel.html

DCMES 1999. Dublin Core Metadata Element Set, Version 1.1: Reference Description
http://www.dublincore.org/documents/dces/

DCQ 2000. Dublin Core Qualifiers
http://www.dublincore.org/documents/dcmes-qualifiers/

EdNA 2000. EdNA Metadata Homepage
http://standards.edna.edu.au/metadata/

Fisher, S, Friesen, N, Roberts, A. 2002. CanCore Intititive Metadata Guidelines Version 1.1
http://www.cancore.org/documents/

Friesen, N, Roberts, A. Fisher, S. 2002. CanCore: Learning Object Metadata
http://www.cancore.org/cancorepaper.doc

Heery, R., Patel, M., 2000. Application Profiles: Mixing and Matching Metadata Schemas. Ariadne, 25.

IEEE LOM, 2002. Learning Object Metadata draft version 6.4
http://ltsc.ieee.org/wg12/index.html

IMS CP, 2002.
http://www.imsglobal.org

ISO 1179. Specification and Standardization of Data Elements, Parts 1-6.
ftp://sdct-sunsrv1.ncsl.nist.gov/x3l8/11179/

Lynch, C.A. 1997. The Z39.50 Information Retrieval Standard. Part I: A Strategic View of Its Past, Present and Future. D-Lib Magazine. April. [Web Page].
http://www.dlib.org/dlib/april97/04lynch.html

ODRL 2002. Open Digital Rights Language
http://www.odrl.net

Ottawa 2001. The Ottawa Communique
http://www.ischool.washington.edu/sasutton/dc-ed/Ottawa-Communique.rtf

TLF 2002. The Le@rning Federation Metadata Application Profile
http://www.thelearningfederation.edu.au/repo/cms2/published/3059/metadata_application_profile_1.1.pdf

OPEN ACCESS

This article is licensed under a **Creative Commons Attribution 4.0 International License**, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and cite the source.

https://doi.org/10.23106/dcmi.952106953