ISO/IEC 19788-1: A metadata framework

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Abstract

The ISO/IEC 19788 family, also known as Metadata for Learning Resources, was created to categorize resources in learning, education, and training contexts. It comprises various parts, such as Part 1: Framework (ISO/IEC 19788-1), initially specifying how to describe learning resources. Its broader applications have made it a horizontal standard for all ISO/IEC JTC1 standards groups promoting the interoperability of descriptions. The paper, written by editors of the standard, overviews ISO/IEC 19788-1's most essential aspects focusing on its underlying principles (such as multilingual or cultural diversity or technical neutrality) and the specification of entities involved in the description of resources (such as properties or application profiles), leaving out less pertinent details for a general presentation.

Keywords: metadata for learning resources; standard; metadata framework; multilingual approach to metadata; application profiles

1 Introduction

We[1] originally designed a family of standards to describe resources used in a learning, education or training context for ISO/IEC with the name: Metadata for Learning Resources (MLR). This family comprises several parts, including Part 1, which we, the authors/editors, will detail here. Currently, it also contains parts specifying properties related to targeted characteristics of resources (e.g. Part 5 describes resources in terms of their use in learning activities, their relation to curricula, etc.), a part related to Dublin Core elements, a part specifying bindings, etc[2].

The ISO/IEC process depends on many National Bodies' support and a team of editors. Consensus is a key requirement in the ISO/IEC process. The ISO/IEC 19788 family of standards were developed in the ISO/IEC JTC1 SC36[3] "Information Technology for Learning, Education and Training" subcommittee with editors following the formal process. The work took several years as experts wrestled with respecting the existing standards and their many implementations and providing for a yet-to-be-more diversified global future.

ISO/IEC 19788-1 Metadata for learning resources – Part 1: Framework[4] was first published in 2011 as a conceptual framework for specifying how to describe learning resources before enumerating the possible characteristics of the resources. However, its use to describe student competencies or accessibility of resources has shown that its use can be broader than the description of learning resources. For this reason, it has been

[1]This first we includes all the people involved in writing this family of standards. The following we includes only the authors of this paper: Yolaine Bourda, Gilles Gauthier and Liddy Nevile are co-editors ISO/IEC 19788-1 and Yong-Sang Cho is the convenor of the working group in which these standards were discussed and he is also co-editor of other parts of the ISO/IEC 19788 family.

[2]For a list of all parts of the ISO/IEC 19788 family, insert '19788' in the search box at https://iso.org/standards.html

[3]Subcommittee 36 of the Joint Technical Committee 1 of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

[4]ISO/IEC 19788-1 (2nd edition) is currently under development and will be available by the end of 2023 or the beginning of 2024.

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promoted by ISO/IEC JTC1 as a horizontal standard (for an example of a standard based on ISO/IEC 19788-1 see section 4) to all standards groups under the aegis of ISO/IEC JTC1. It is therefore applicable for specifying metadata about any kind of resources.

Over the years, several metadata standards have been developed, each with its unique approach and focus. The Dublin Core Metadata Element Set (DCMI, 2020) is a well-established standard that provides a simple and generic approach to describing various types of digital resources. LRMI (Barker and Campbell, 2015) and LOM (IEEE, 2020 for the latest edition [5]) can be mentioned regarding the description of learning resources. Although old and suffering from many imperfections, including the difficulty of producing an RDF binding that fully satisfies the LOM model (Nilsson et al., 2003), the LOM is widely used in many non-interoperable application profiles (see for example Castro-García and López-Morteo, 2013). The LRMI, recent and rather intended for the description of online resources, is specified in RDF. This is advantageous for inserting descriptions into the web of data but also the many implementations in different technologies (such as widely used databases of organizations). These schemes are not technologically neutral and have not been designed for use in a multilingual and multicultural context. None of them specifies how to define application profiles.

The MLR[6] is based on several fundamental principles including considering the diversity of cultural and linguistic contexts or technological neutrality.

Resource descriptions are fundamentally property-based; however, not all properties apply to all types of resources. Different types of resources, such as people or books, require different descriptions. Therefore, when defining a property, it is essential to designate a domain encompassing all entities or resources to which it may apply.

A key aspect of the MLR is the concept of a resource class, which is a set of resources sharing similar properties (e.g. books, people). Inheritance relationships can interlink classes, which is very similar to the idea of a subset. If class A inherits from class B, all instances of A are also instances of B and are instances of all classes B inherits from. MLR supports multiple inheritance, allowing a resource to belong to two non-hierarchical classes. Additionally, declaring a class instance before describing a resource is not mandatory. If a resource is the subject of a property, this implies that the resource is an instance of the class declared as the property's domain.

The value of a property can either be literal data, such as a specific date (e.g., a birth date), a term from a controlled vocabulary, or a resource denoted by an identifier (e.g., a book's author as a resource with its characteristics, which can be linked to additional resources and so forth).

In 2020, a revision of the standard was undertaken by the editors. Its adoption as a horizontal standard within JTC1 brings a new perspective to its utility and importance in the field. Edition 2 offers significant enhancements compared to edition 1.

In this paper, we explain the main aspects of the standard ISO/IEC 19788-1 (Edition 2), leaving aside some points that are undoubtedly important but irrelevant in a general presentation of this standard.

The paper is organized as follows: section 2 presents the underlying principles behind the development of the ISO/IEC 19788 family of standards, section 3 shows how to specify MLR entities, section 4 presents a case of using ISO/IEC 19788-1 to specify a standard outside the ISO/IEC 19788-1 family of standards, and finally, the conclusion is exposed in section5.

2 Key principles

The ISO/IEC 19788 family of standards (and therefore the standard ISO/IEC 19788-1) is based on some fundamental principles underpinning its development.

2.1 A multipart standard

The ISO/IEC 19788 is from the outset a multipart standard, thus ensuring an integrated and modular approach. Each part has its scope and purpose, is self-contained and is, therefore, a standard in its own right. This facilitates the use and maintenance of specific parts and, thus, the whole standard. In addition, it simplifies

[5]The 2020 edition does not bring any substantial changes to the 2002 edition.

[6]In this paper, we use the acronym MLR to refer to the principles underlying the ISO/IEC 19788 family of standards, to refer to concepts that have a specific meaning in this context (e.g. MLR identifier to refer to a particular type of identifier that follows the rules for identifiers specified in the ISO/IEC 19788-1 standard)

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the development of new parts and altogether new standards to meet new needs over time. Thanks to this approach, Part 1 gained the status of a horizontal standard which could not have been the case if this conceptual framework had been mixed with the specifications of particular properties.

2.2 Multilingual and cultural diversity

One of the main objectives of the ISO/IEC 19788-1 standard is to support multilingualism and cultural diversity, recognising that learning resources are created and used in different linguistic and cultural contexts. Moreover, therefore so is their metadata. Allowing everyone to use their language is essential, especially in an international context. English, although widely spoken, is not the only language.

An amusing example of linguistic and cultural diversity is the translation into French of "learning resource": in Québec, Canada, it is called "ressource d'apprentissage" and in France "ressource pédagogique".

In the standard, multilinguality is accomplished by employing language and culture-neutral identifiers, allowing an identifier (e.g., for a property, a resource class or a vocabulary term) to be associated with a designation in the desired language, thereby enabling as many different names as languages. These identifiers serve as a reference, allowing unambiguous identification and cross-referencing of specified entities across distinct implementations and contexts.

To support cultural and linguistic diversity, files will be available on the ISO website in machine-readable formats. For example, Figure 1 shows a JSON file snippet containing the labels for a property from the ISO/IEC 4932 standard [7] under development. Illustrated are the three official ISO languages, other languages may be made available.

```
"ISO_IEC_4932::P0001": {
"label": {
    "en": "accessibility summary",
    "fr": "résumé de l'accessibilité",
    "ru": "краткое описание доступности"
},
```

Figure 1: Example of alternative language versions for a label

2.3 User extensions

Experience has shown that a standard only sometimes meets the needs of a particular community and that the community often has specific requirements, such as the need to add properties or to put constraints in terms of presence or repetition requirements. It is, therefore, necessary to provide a standard that is open to extensions. In the MLR approach, extensions are possible through application profiles. However, it is also necessary, to preserve the interoperability of these profiles as much as possible, to foresee how to specify them together with the standard on which they are based.

Often, a problem in defining application profiles is reusing entities defined by other organisations. It is not wise to have to redefine them; therefore, the MLR approach should support (some) user extensions.

2.4 Technological neutrality

Another essential principle is the technological neutrality of the ISO/IEC 19788 family, meaning it does not prescribe specific technologies or platforms for implementing the metadata framework. This approach ensures the standard remains relevant and applicable across various technological landscapes, from traditional databases and content management systems to emerging technologies such as linked data, semantic web and knowledge graphs. The properties of the resources are thus defined at a conceptual level allowing bindings in different technologies. The importance of open and linked data has been taken into account, and the binding of ISO/IEC 19788 family to this environment is natural.

[7] Information technology – Learning, education and training – Access For All Metadata: Accessibility Core Terms (AfA-core-terms)

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2.5 Promote interoperability and the deployment of ISO/IEC 19788-1

To promote the deployment of standards based on the ISO/IEC 19788-1 standard and thus interoperability between them all, the ISO/IEC 19788-1 standard is available on the ISO website [8].

Although this standard is technology-neutral, the amount of data available in RDF/OWL format is such that it cannot be ignored. Moreover, unlike a proprietary application whose implementation is only relevant to its users, the web of data is inherently open. Therefore, each user must share the same binding. This is why an RDF/OWL ontology containing all the class and property specifications will be available on the ISO Standards Maintenance Portal[9].

3 Specification of MLR entities

3.1 MLR identifiers

ISO/IEC 19788-1 indicates how to specify specific identifiers called, in this context, MLR identifiers. These identifiers are linguistically neutral and are constructed from the reference of the standard, its year of publication and a part specifying the purpose of the identification (for example, RC for a resource class or P for a property). These identifiers can be automatically transformed into IRIs using RFC 5141 (Goodwin and Apel, 2008).

Example of an MLR identifier: ISO_IEC_19788-1:2023::RC0002 (identifier of the resource class Learning Resource specified in version 2023 of the ISO/IEC 19788-1 standard)

Canonical identifiers offer a means to capture the shared "essence" of fundamentally identical entities. Generally, the description accompanying such an identifier represents the most recent version of the entity's specification or description. An MLR canonical identifier is based on the MLR identifier (here, removing the year of the standard).

Example: The MLR canonical identifier associated with the above identifier is ISO_IEC_19788-1::RC0002.

3.2 Specification of resource classes

A resource class represents a collection of resources that can be distinctly defined with clear boundaries and meaning, sharing common characteristics and adhering to the same rules. For instance, examples of resource classes include the collection of all learning resources (Learning Resource), the collection of all persons (Person), and the collection of all documents (Document). It is important to note that this concept of class closely resembles the notion of a set and should not be confused with the idea of a class in programming languages.

Specifying a resource class involves explicitly providing the values of a series of attributes. Each resource class specification encompasses the following attributes:

- Identifier: the identifier of the resource class. This identifier follows the MLR rules for a resource class identifier.
- Canonical identifier: the canonical identifier of the resource class.
- Label: the label of the resource class. Several linguistic equivalents can be provided, and each language is indicated using a code from the standard ISO 639-3 (ISO, 2007). The label is for human consumption.
- Name: the name of a resource class. This is a string usually constructed from the label of the resource class, conforming to the production rule for Name in the XML W3C Recommendation (Paoli et al., 2008). As for the label, several linguistic equivalents could be provided.
- Definition: the definition of the resource class. A statement that explains the meaning of this resource class through a concise explanation of its essential features or characteristics.
- Subclass of [multiple inheritance]: an identifier of a superclass or a list of identifiers of superclasses for this resource class.
- Note: any additional information relevant to the class.

[8] https://standards.iso.org/ittf/PubliclyAvailableStandards/
[9] https://standards.iso.org/iso-iec/

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A comprehensive and detailed description of a resource class can be achieved by assigning values to these attributes. This is done by completing a specific template (cf Figure 2 for an example of a specification of a resource class).

Resource class specification	
Identifier	ISO_IEC_19788-1:2023::RC0005
Canonical identifier	ISO_IEC_19788-1::RC0005
Label	Web Resource
Name	WebResource
Definition	Instances of this class are the information resources that 'lives on the World Wide Web'
Subclass Of	ISO_IEC_19788-1::RC0004 (*Information Resource*) ISO_IEC_19788-1:2023::RC0006 (*Representation*)
Note	-

Figure 2: Example of a resource class specification

3.3 Specification of properties

Resource descriptions are essential for their identification and use in different contexts. They rely on the use of properties, which make it possible to specify the characteristics of resources in detail.

In the context of the ISO/IEC 19788 standard, the specification of a property consists of providing a value for each of the following attributes (those in bold are essential attributes):

- **Identifier**: the identifier of the property. This identifier follows the MLR rules for a property identifier
- **Canonical identifier**: the canonical identifier of the property.
- **Label**: the label of the property. Several linguistic equivalents can be provided, and each language is indicated using a code from the standard ISO 639-3 (ISO, 2007). The label is for human consumption.
- **Name**: the name of the property. This string is usually constructed from the property's label, conforming to the production rule for Name in the XML W3C Recommendation (Paoli et al., 2008). As for the label, several linguistic equivalents could be provided.
- **Definition**: the definition of the property. A statement that explains the meaning of this property through a concise explanation of its essential features or characteristics.
- **Domain**: the identifier of a resource class the subjects for this property belong to.
- **Codomain**: a set containing all the possible property values; it can be either the token *literal* (for sets of literals or vocabulary terms) or the identifier of a resource class.
- **Linguistic indicator**: an indicator specifying, if the attribute Codomain has the value *literal*, whether the values this property can take are language dependent. The possible values are *linguistic*, *non-linguistic* or *both*.
- **Content value rules**: the identifier of a set of rules, if the attribute Codomain has the value *literal*, describing the possible data values (literals) for the property.
- Refines: the identifier of a super-property for the property.
- Example(s): some examples of the use of the property.
- Note(s): any additional information.
- Best practice(s): some good practices for using the property.

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- Status: information on the fact that the property is still in use. The possible values are *current* (default value) or *deprecated*.

Property specification	
Identifier	ISO_IEC_ 19788-2:2024::P0300
Canonical identifier	ISO_IEC_ 19788-2::P0300
Label	subject
Name	subject
Definition	topic of the learning resource
Domain	ISO_IEC_19788-1::RC0002 (*Learning Resource*)
Codomain	*literal*
Linguistic indicator	*linguistic*
Content value rules	ISO_IEC_19788-1::PRS0001 (*MLR String*)

Figure 3: Example of a property specification (partial)

Property specification	
Identifier	ISO_IEC_ 19788-2:2024::P1700
Canonical identifier	ISO_IEC_ 19788-2::P1700
Label	subject
Name	subject
Definition	topic of the learning resource
Domain	ISO_IEC_19788-1::RC0002 (*Learning Resource*)
Codomain	ISO_IEC_19788-1::RC0004 (*Information Resource*)
Linguistic indicator	N/A
Content value rules	N/A

Figure 4: Example of a property specification (partial)

Figures 3, 4 and 5 are examples of parts of property specifications. Figure 3 shows a property whose possible values are linguistically significant character strings. Figure 4 shows a property whose possible values are class instances. And Figure 5 shows a property whose possible values are identifiers of terms in a vocabulary (note the value *non-linguistic* for the attribute linguistic indicator although the codomain attribute has the value *literal*). A rule set accompanies this property specification.

There is no indication in the specification of a property as to whether it is mandatory or optional or its cardinality, as these characteristics are defined in application profiles.

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Property specification	
Identifier	ISO_IEC_4932:2023::P0002
Canonical identifier	ISO_IEC_4932::P0002
Label	access mode
Name	accessMode
Definition	human sensory characteristics of a resource through which intellectual content is communicated
Domain	ISO_IEC_19788-1::RC0004 (*Information Resource*)
Codomain	*literal*
Linguistic indicator	*non-linguistic*
Content value rules	RS_P0002

Rule_Set_ID: RS_P0002	
Rule_ID	Rule statement / Example(s) & Note(s)
01	The possible values are identifiers of terms from vocabulary ISO_IEC_4932::V0001 (*Access mode*).

Figure 5: Example of a property specification (partial)

3.4 Specification of vocabularies

By utilizing the "Content value rules" attribute in a property's specification, it is possible to limit the values of this property to a specific collection of terms (identified by their respective identifiers) from a given controlled vocabulary. ISO/IEC 19788-1 also indicates how to specify vocabularies and how they can be extended while preserving the interoperability of descriptions. Some communities need to introduce additional terms to an already established vocabulary. Instead of creating an entirely new vocabulary, extending an existing one is possible, thus maintaining interoperability. When a vocabulary is an extension of another, it includes all the terms from the original vocabulary and any new terms defined by the extension. The "Open/closed" attribute of the original vocabulary must be set to "open" to indicate that it can be extended in this manner.

In the context of ISO/IEC 19788-1, the specification of a vocabulary consists of providing a value for each of the following attributes:

- Identifier: attribute similar to the other specifications (cf section 3.2)
- Canonical identifier: attribute similar to the other specifications (cf section 3.2)
- Label: attribute similar to the other specifications (cf section 3.2)
- Name: attribute similar to the other specifications (cf section 3.2)
- Open/closed: information on whether the vocabulary is extensible or not. The possible values are *open* and *closed*.
- Extension of: the identifier of a vocabulary being extended.
- Set of terms: the set of terms belonging to the vocabulary. For each term, an identifier and a label are to be provided. In the case of one vocabulary extending another: only the new terms are to be given here, and new terms shall be related to existing terms of the extended vocabulary using one of the possible relations between terms. For a term, one can give, if relevant, the other terms to which it is related using the relationships from SKOS – Simple Knowledge Organization System (Isaac and Summers, 2009): broader, narrower, related, broaderTransitive and narrowerTransitive.

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Vocabulary specification				
Identifier	ISO_IEC_4932:2023::V0001			
Canonical identifier	ISO_IEC_4932::V0001			
Label	Access mode			
Name	AccessMode			
Open/closed	closed			
Extension of	-			
Set of terms				
Term_ID	Related terms	Label	Name	Definition
T010	-	auditory	auditory	The resource contains information encoded in auditory form.
T020	-	chart on visual	chartOnVisual	The resource contains charts encoded in visual form.
T030	-	chem on visual	chemOnVisual	The resource contains chemical equations encoded in visual form.
...				

Figure 6: Example of a vocabulary specification (partial)

3.5 Specification of application profiles

An application profile is a collection of properties chosen to satisfy the particular needs of a community. In an application profile, one specifies whether each property is mandatory or optional and its cardinality. The properties in an application profile and the constraints that apply to each are declared class by class. For each class, it is necessary to specify the properties whose domain is the stated class, which are present in the application profile and the constraints they obey.

Some communities need to introduce additional constraints to an already established application profile. Instead of creating an entirely new application profile, extending an existing one is possible, thus maintaining interoperability.

In the context of ISO/IEC 19788, the specification of an application profile consists of providing a value for each of the following attributes:

- Identifier: attribute similar to the other specifications (cf section 3.2)
- Canonical identifier: attribute similar to the other specifications (cf section 3.2)
- Label: attribute similar to the other specifications (cf section 3.2)
- Name: attribute similar to the other specifications (cf section 3.2)
- Description: the purpose of the application profile.
- Extension of: the identifier of the application profile extended by the one under definition.
- List of identifiers of templates for property constraints: one template per resource being a domain considered in the application profile.

Figures 7 and 8 illustrate the specification of property constraints associated with an application profile specification. Figure 7 shows a property constraint table specifying for each property whose domain is the resource class ISO_IEC_19788-1::RC00002 (*Learning Resource*) its presence type indicator, its repeatability indicator, its order indicator and the order meaning. It is accompanied by Figure 8 showing for each property whose presence type indicator has the value *conditional*, what the condition consists of.

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Property constraints (PC)					
PC identifier	PC0001				
Underlying domain	ISO_IEC_197881::RC0002 (*Learning Resource*)				
Property identifier	**Property name**	**Presence Type indicator**	**Repeability indicator**	**Order indicator**	**Order semantic**
ISO_IEC_19788-2::DES0100	title	*mandatory*	*non-repeatable*	-	-
ISO_IEC_19788-2::DES0200	creator	*conditional* (C0001)	*repeatable*	*ordered*	In order of importance, most important first
ISO_IEC_19788-2::DES0300	subject	*conditional* (C0002)	repeatable	*ordered*	In order of importance, most important topic first
ISO_IEC_19788-3::DES0200	description	*conditional* (C0002)	*repeatable*	*unordered*	-
ISO_IEC_19788-2::DES0500	publisher	*optional*	*repeatable*	*ordered*	In order of importance, most important first
ISO_IEC_19788-2::DES0600	contributor	*conditional* (C0001)	*repeatable*	*ordered*	In order of importance, most important first
...					

Figure 7: Example of a property constraint table in an application profile specification

Conditions Table	
Code ID	**Conditions**
C0001	a "creator" property or a "contributor" property shall be present for each instance of the class being described.
C0002	A "subject" property or a "description" property shall be present for each instance of the class being described.

Figure 8: Example of a condition table accompanying a property constraint table in an application profile specification

4 An example of a specification based on ISO/IEC 19788-1

While ISO/IEC 19788-1 specifies how ISO/IEC standards and ISO/IEC 19788-1 conforming metadata profiles might be defined, it enables users to develop new ways of supporting resource discovery and use. It is this outreach that matters in the end to the user.

Regarding accessibility to resources, disability is increasingly defined as a mismatch between a user's access needs and preferences and the properties of a resource. It is not the case that users' needs define their disabilities (in the medical sense). AccessForAll metadata is strictly about defining resource attributes, not people or their attributes. This is made clear in ISO/IEC 4932, a standard for the description of core properties for sensory perception attributes of resources.

The World Wide Web Consortium (W3C) provides specifications for encoding information and services to overcome access limitations so resources can be configured or transformed to suit users' individual needs. AccessForAll (AfA) metadata standards enable users to decide which attributes they want to work with. Making all resources and their components available in all possible combinations is not likely to happen. In fact, not all accommodations are needed by all users and for some accommodations, perhaps alternative components can be sourced elsewhere or produced as needed. This 'just-in-case' scenario complements

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W3C specifications so the accessibility burden on resource providers can be significantly reduced in some circumstances (for example when providing particular identified students with reference materials).

ISO/IEC 4932 is a standard defined following ISO/IEC 19788-1 specifications. The core properties can be refined or extended using ISO/IEC 19788-1 application profile rules without loss of interoperability. The properties are defined so they can have well-known English names or any others in any language without compromising interoperability. The alternative language versions can be published on the ISO website in machine-readable form, following ISO/IEC 19788-1 (for an example, see Figure 1)

In some cases, the description of the attributes of resources as needed by a user can be stored as a 'personal needs and preferences profile' (PNP). Resources can, in the usual way, have descriptions of their attributes using the same properties in a 'digital resource description' (DRD). For some users, storing a PNP is essential for its easy use in resource discovery and delivery, particularly when the user might not be capable of configuring it for themselves. Users may want to have more than one PNP so they can choose the one that best suits their immediate context.

In drafting ISO/IEC 4932, the ISO team found immediate benefits in using the ISO/IEC 19788-1 standard, among them the framework's usability reducing the time needed to produce this standard.

5 Conclusion

This paper has outlined the ISO/IEC 19788-1 standard (2nd edition). We have presented the underlying principles on which the original and the edited version were designed, illustrated the specification of MLR entities, and provided an example of a standard that used it as a foundation.

For a standard based on ISO/IEC 19788-1, beyond the obvious technical benefits of conforming to the ISO/IEC 19788-1 are the benefits from the MLR principles: immediately, the standard can function using multiple languages and global values as it is as consistent as possible with older schema used globally in educational contexts; it is technology neutral so it can continue operating in the future, and there is integration in the MLR world. The ISO/IEC 19788-1 has been designated a horizontal standard for ISO so MLR properties can easily be integrated into a wide range of metadata systems.

With the work on ISO/IEC 19788-1 (2nd edition) almost finalised, shortly, a second edition of the other parts of the ISO/IEC 19788 family should be produced quickly.

Finally, we hope this work will serve UNESCO's Open Educational Resources (OER) ambitions. Indeed, in its 2019 recommendations UNESCO, 2019, one of the five objectives on OER is "building capacity of stakeholders to create, access, re-use, adapt and redistribute OER". This includes "...with interoperation of metadata, and standards (including national and international) to help ensure OER can be easily found, accessed, re-used, adapted and redistributed in a safe, secure and privacy-protected mode.".

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