TECHNICAL REPORT

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Information technology — Learning, education and training — Conceptual Reference Model for Competency Information and Related Objects

Technologies de l'information — Apprentissage, éducation et formation — Modèle de référence conceptuel pour compétences et objets liés

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In exceptional circumstances, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may propose the publication of a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 24763 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

0 Introduction

0.1 General

There are currently several existing and implemented models providing competency information related to learner knowledge, skills, capabilities, qualifications, performance, learning objectives, and other related objects. Some of these models do not interoperate because of lack of clarity or consistency of the semantics. The primary purpose of this Technical Report is to provide an information technology for learning, education and training (ITLET) Conceptual Reference Model (CRM) that will support consistency and enhance understanding and interoperability of various existing competency information models across learning, education and training (LET) communities.

This Technical Report provides both the ITLET Conceptual Reference Model and a process that may be used to compare and enable exchange of data between heterogeneous information models across LET communities. The ITLET Conceptual Reference Model is a common reference point against which divergent and incompatible sources of information can be compared and, ultimately, harmonized. It may also be used as a basis for the assembly of new models and related standardization work.

The standardization concept is that the ITLET Conceptual Reference Model can be used as a “fundamental level” of modelling to complement the currently accepted levels of 1) semantic model or meta-model, 2) information model, 3) data model. It defines a framework for building potential information models related to competencies as represented in LET information technology systems by providing classes and properties that are common across multiple use cases and mappings of existing metadata onto these classes. These classes and properties provide reference points for attributes and information structures included in the information models. The information models in turn can be used to develop frameworks that may be used to develop bindings to specific data structures and formats.

This Technical Report provides a common model and format to clarify the logic of information types and relationships that are used in LET information technology systems underlying the information systems related to competencies that are used by LET organizations and their respective communities. It is important to note that this Technical Report aims to clarify the logic of information types and relationships that are used in information technology systems by LET organizations and their communities in order to manage, develop, describe, transfer or assess competency information or other related objects. This Technical Report is primarily informative in content.

Challenges that have been identified include (but are not limited to) the need for competency standards to:

- accommodate complex competency information structures,
- provide adequate linkages to competency information that resides within different IT systems,
- provide support for comparisons of competency information, across diverse communities and contexts, and
- allow for the monitoring and updating of competency information related to individual learners.

IT systems managing competency information face many challenges, such as the following.

- There is no single definition of competency that is accepted by all. Instead, there are many definitions, using different structures and vocabularies, describing different levels of competency.
- It has even been suggested that competency is an unobservable entity, and therefore that it cannot be traced, measured or recorded.

- IT systems may be designed, developed, and implemented with specific labels for competency information in mind, according to the context in which it is used (see Clause 8).

- IT systems need to provide cost-effective support for the description of competencies at multiple levels of abstraction and in various formats.

- IT systems may need to comply with international, national and regional legislative requirements.

- Competency information may be associated with identifiable individuals, and could be used to make decisions related to employment, advancement, admission, accreditation, etc. When competency information is related to an identifiable individual, then privacy protection of this individual is essential.

Therefore, competency information standards should protect the privacy and integrity of that information. They should allow flexible methods for sharing that information under the control of the person or people described by that information. There is also a need to aggregate and normalize information about the competency of multiple individuals to support decision-making by organizations. Therefore, competency standards should support the description of competencies at multiple levels of abstraction. Many stakeholders have an interest in competency information, all with different views of the information and different terminologies about competency information.

Each different LET institution may be supported through the use of specific information systems that consist of digital products and services selected to support the institutional mission. The process of the delivery of digital products from point(s) of origin (provider) to destination (stakeholder) to support LET can be described using a Digital Services Supply Chain (DSSC) approach. There currently are several existing and implemented models providing competency information related to learner knowledge, skills, capabilities, qualifications, performance, learning objectives, and other related objects. These models are implemented in various ways, and the relationships inherent within the models may be made explicit by applying a DSSC approach to real-world implementations of competency information models. Thus, a challenge for competency information standards is to provide methods for taking advantage of existing information about competencies in current and emerging IT systems that are used to manage, develop, describe, transfer or assess competency information or other related objects.

0.2 Areas of applicability

This Technical Report applies to activities including:

a. Assistance with understanding competency as it is measured and observed within an IT system and the description and process by which the ITLET Conceptual Reference Model may be used as a common reference point to facilitate the exchange and management of information for IT systems that support the management, development, description, transfer or assessment of competency information or other related objects.

b. The use of an ITLET Conceptual Reference Model toolkit that includes:

   - the ITLET Conceptual Reference Model that comprises classes of entities and relationships, which include concepts such as competency, actor, action, outcome, evaluation, assessment process, and other related concepts or objects;

   - procedure to gather information regarding individual use cases;

   - process to describe the competency information within different systems and to derive system information models;

   - general information and a detailed example of the application of the ITLET Conceptual Reference Model toolkit that allows for elaboration of information models, the determination of competency information objects and competency information records.

c. Guidance regarding a process to assist with the exchange of competency information between and amongst IT systems used by and developed for LET communities.

d. A common model and format to identify common information contents that are in different data formats; in particular to support the implementation of automatic data transformation algorithms from local to global data structures without loss of meaning. These transformation algorithms are useful for data exchange, data migration from legacy systems, data information integration, and mediation of heterogeneous sources.

e. Support for associative queries against integrated resources by providing a central model of the basic classes and their associations to formulate such queries.

0.3 Overview of the structure of this Technical Report

The structure of this Technical Report includes nine clauses and four informative annexes.

- Clause 1 describes the scope.
- Clause 2 provides terms and definitions used in this Technical Report.
- Clause 3 provides symbols and abbreviations used in this Technical Report.
- Clause 4 provides a graphical representation of the ITLET Conceptual Reference Model, which provides an introduction to the relationships between the classes and properties.
- Clauses 5 and 6 provide more detailed information regarding the ITLET Conceptual Reference Model classes and properties.
- Clause 7 provides an overview of how to use the ITLET Conceptual Reference Model, and introduces the topics of sharing and aggregating competency information (7.2, 7.3), deriving query requirements and information model structures (7.4), supporting interoperability requirements (7.5), and using metadata to build competency information objects (7.6).
- Clause 8 discusses the representation of competency within ITLET, the nature of competency as it is considered within the context of ITLET, and the challenges inherent for competency information standards within the context of ITLET.
- Clause 9 briefly notes potential areas where further international standardization may need to be considered.
- Annex A (informative) provides more detailed information regarding the development of an information model from the ITLET Conceptual Reference Model. This informative annex is closely related to Clauses 7 and 8, which provide an abbreviated version of the process and several briefer examples.
- Annex B (informative) provides a specific example of a use case.
- Annex C (informative) provides an overview of the development of the ITLET Conceptual Reference Model and explains the genesis of the model itself.
- Annex D (informative) provides a table of brief descriptions of the use cases submitted by National Bodies and a template used to support the development of this Technical Report.

0.4 Acknowledgement

The main source of inspiration for this Technical Report is the CIDOC Conceptual Reference Model produced by the ICOM/CIDOC Documentation Standards Group and continued by the CIDOC CRM Special Interest Group (http://cidoc.ics.forth.gr/), published as ISO 21127:2006[1)]. Although it is the main source of inspiration for this Technical Report, it is not a normative reference for it.

1) See Bibliography. ISO 21127:2006 establishes guidelines for the exchange of information between cultural heritage institutions. It is developed and maintained by ISO/TC 46, *Information and documentation*, SC 4, *Technical interoperability*.

Information technology — Learning, education and training — Conceptual Reference Model for Competency Information and Related Objects

1 Scope

1.1 Purpose

This Technical Report provides a Conceptual Reference Model that comprises categories of items, attributes, and relationships. It can be used to identify the relationships between concepts represented within an information technology for learning, education and training (ITLET) system, such as competency, knowledge, skills, capabilities, qualifications, performance, and learning objectives. It can be used to identify related objects that are used to convey competency information. This Technical Report pertains to the exchange and integration of heterogeneous information relating to information technology (IT) systems that are used by learning, education and training (LET) organizations and their communities in order to manage, develop, describe, transfer or assess competency information or other related objects. The scope is further elaborated as follows.

- This Technical Report provides guidance regarding the level of detail and precision expected and required to describe, in relation to the ITLET Conceptual Reference Model, IT systems that are used to manage, develop, describe, transfer or assess competency information or other related objects within the LET fields.

- This Technical Report provides a definition of competency (ITLET) specific to competency as it is represented within an IT system. This definition is not domain dependent and acknowledges the unique challenges of representing competency information within IT systems (some of which are further elaborated in 8.2).

- This Technical Report is intended specifically to introduce requisite contextual information, i.e., the environment, which can, for example, include information such as location description, duration, date and time.

- The exchange of relevant information from IT systems among LET organizations and their communities, and harmonization with their models, fall within the scope of this Technical Report.

- This Technical Report introduces the topic of privacy needs as they relate to IT systems that are used by LET organizations in order to manage, develop, describe, transfer or assess competency information or other related objects.

- This Technical Report focuses on information about participants, related elements, and the respective relationships included within IT systems in LET that are used to manage, develop, describe, transfer or assess competency information or other related objects.

1.2 Primary role

The primary role of this Technical Report is to enable the integration and interoperability of heterogeneous sources of competency information. This Technical Report provides a toolkit comprising the ITLET Conceptual Reference Model and processes needed to elaborate semantic definitions and clarifications to transform and enable the exchange of information across disparate, localized information sources into a coherent global

resource. The ITLET Conceptual Reference Model can be used as a common reference point, and the process described in this Technical Report can be used to assist human understanding of IT system(s) used within LET to manage, develop, describe, transfer or assess competency information or other related objects.

1.3 Aspects not currently addressed

This Technical Report does not address the following aspects.

a. the conception that competency is an unobservable and unmeasurable entity;

b. specific details related to the functions of the classes;

c. the creation of data models and complex data structures;

d. guidelines related to the use of such data models, or to their bindings;

e. Application Program Interfaces (APIs) and associated bindings;

f. specific relationships to other ISO/IEC International Standards and detailed descriptions of related work by other organizations;

g. multilingual support;

h. cultural adaptability;

i. a detailed overview of privacy issues;

NOTE Privacy within ITLET systems will be the subject of a future International Standard (ISO/IEC 29187).

j. guidance regarding accessibility issues;

NOTE See ISO/IEC 24751 (all parts) for more information on accessibility with ITLET systems.

k. a detailed explanation and guidance regarding the application of a Digital Services Supply Chain (DSSC) approach to competency information model implementations;

l. guidance regarding best practice in conceptual modelling for information technology systems.

It is anticipated that some or all of these requirements will be addressed in future editions of ISO/IEC 24763, or in companion International Standards or Technical Reports.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
class
category of items that share one or more common **properties**, which serve as criteria to identify items that belong to the class

NOTE 1 Within the ITLET Conceptual Reference Model for Competency Information and Related Objects, there are nine classes: Action; Actor; Competency; Criteria and method; Environment; Evaluation, assessment process; LET institution; Outcome; and Role.

NOTE 2 Class properties need not be explicitly formulated in logical terms, but may be described as a statement that refers to a common conceptualization of domain experts. The sum of these properties is called the intension of the class. A class can be the domain or range of none, one, or more properties formally defined in a model. The formally defined properties need not be part of the intension of their domains or ranges: such properties are optional.

NOTE 3 Adapted from ISO 21127:2006 (3.1).

2.2
competency
⟨ITLET⟩ observable or measurable ability of an actor to perform a necessary action(s) in a given context(s) to achieve a specific outcome(s)

NOTE See Clause 8.

2.3
competency information
⟨ITLET⟩ data about a **competency** that may be aggregated for communication among individuals, organizations, and public administrations

NOTE Competency information may reside in one or several competency information records, and may be associated with other types of information related to an individual or an organization.

2.4
competency information object
⟨ITLET⟩ set of information that is structured to facilitate communication about **competency** among individuals, organizations, and public administrations

NOTE In order to facilitate communication and exchange, a competency information object may be formatted in an agreed upon manner by combining competency information that is contained in one or more competency information records.

2.5
competency information record
⟨ITLET⟩ set of recorded information describing **competency**

2.6
digital services supply chain
⟨ITLET⟩ process of the delivery of digital products from a point(s) of origin (provider) to a destination (stakeholder) to support learning, education and training

2.7
environment
⟨ITLET⟩ context, surroundings or conditions in which a person lives or operates

NOTE Environment (ITLET) is a class within the ITLET Conceptual Reference Model for Competency Information and Related Objects.

2.8
ITLET conceptual reference model
definitions and a common structure for describing the implicit and explicit concepts and relationships within an information technology (IT) system for learning, education and training (LET)

2.9
LET institution
any institution delivering learning, education or training (LET) services, whether they be formal or non-formal

EXAMPLE A social or decision-making body, an organization, a government ministry, a community of learners, a professional certifying body, a person, etc.

NOTE LET institution is a class within the ITLET Conceptual Reference Model for Competency Information and Related Objects.

2.10
object
something that is perceivable or conceivable

NOTE 1 Objects may be material (e.g., resume, paper transcript, computer), immaterial (e.g., virtual environment, streaming video) or imagined (e.g., a unicorn).

NOTE 2 Adapted from ISO 1087:2000 (3.1.1).

2.11
property
characteristic of a **class** that states the specific relationship that exists between two **classes**

NOTE 1 A property is characterized by an intension, which is conveyed by a statement or a scope note.

NOTE 2 Within this Technical Report, Clause 6 identifies each of the distinct properties, i.e., characteristics of each member of a **class**, which are identified and defined in Clause 5.

NOTE 3 Adapted from ISO 21127:2006 (3.14).

3 Symbols and abbreviated terms

The following symbols and abbreviations are defined for use within this Technical Report.

Symbols

[ ] Square brackets – denotes a class, subclass, or instance related to a class in clauses 5, 6, 7.4, 7.6 and Annexes B and C.

{ } Curly brackets – used to denote examples of subclasses in clauses 5 and 6. Used in clause 7.4 to help denote examples of sets and subsets of information that form competency information objects.

( ) Brackets or parentheses – used throughout the document to provide parenthetical or additional information. Used in clause 6 to denote range-to-domain relationships. Used in clause 7.4 to help denote examples of sets and subsets of information that form competency information objects.

$\cup$ Union – This symbol represents a basic binary operation in set theory known as union. The union of two sets is denoted as A $\cup$ B, which indicates a set that includes all the sub-components that are included in at least one of A or B. For example, the union of (1, 2) and (2, 3) is the set (1, 2, 3). The use of this symbol in clause 7.4 is intended to provide support for queries, not necessarily to create data models but to create sets of information.

$\subset$ Subset of – This symbol represents a subset. For example, if set A = (1, 2, 3) and set B = (1, 2, 3, 4), then A is a subset of B. In this Technical Report this is described using the notation A $\subset$ B. Whereas, if set C = (1, 5), then it is not a subset of B. This is provided as an illustrative example only; additional notational formats are described elsewhere in formal texts related to set theory.

Abbreviations

API Application Program Interface

CRM Conceptual Reference Model

CWA CEN Workshop Agreement

DCMI Dublin Core Metadata Initiative

DSSC Digital Services Supply Chain

HRIS	Human Resources Information System
HR-XML	Human Resources **XML**
ICT literacy	Information and Communication Technology literacy
	NOTE This also may be referred to as **IT** literacy or as **IT** fluency.
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IMS	IMS Global Learning Consortium, Inc.
ISO	International Organization for Standardization
IT	Information Technology
ITLET	Information Technology for Learning, Education, and Training
LET	Learning, Education, and Training
LOM	Learning Object Metadata
MLR	Metadata for Learning Resources
SIS	Student Information System
QTI	Question Test Interoperability
RCD	Reusable Competency Definition
RDCEO	Reusable Definition of Competency or Educational Objective
XML	eXtensible Markup Language

4 Introduction to the ITLET Conceptual Reference Model for Competency Information and Related Objects

A Conceptual Reference Model is typically the most abstract level of the standardization process. The ITLET Conceptual Reference Model provides definitions and a formal structure for describing implicit and explicit concepts and relationships for competencies and related objects within an IT system. It provides a model against which heterogeneous information models may be compared. The ITLET Conceptual Reference Model can be used to gain understanding of the types of information different organizations/institutions/government agencies encode, and facilitate interoperability by providing a framework for considering who, what, how, when, why, and where information is being encoded, thus enabling the leveraging of information within existing systems.

IT systems that support the management and exchange of competency information may exist in varying levels of complexity and capture, store, and exchange diverse types of information. The approach taken in this Technical Report has been inspired by the museum world in which an ISO/IEC standard can be used to help understand IT systems and to support interoperability by providing a flexible and consistent way of thinking about information models. The ITLET Conceptual Reference Model approach allows for the identification of groupings of information that represent a concept regardless of the label that has been placed upon the information in actual IT systems. It is recognized that not all concepts denoted in the ITLET Conceptual Reference Model are represented in all IT system information models. However, by referring to the ITLET Conceptual Reference Model it is possible to identify which concepts are present within an IT system