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Information technology for learning, education and training — Information model for competency —

Part 1: Competency general framework and information model

Technologies de l'information pour l'apprentissage, l'éducation et la formation — Modèle d'information pour les compétences —

Partie 1: Cadre général des compétences et modèle d'information

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Contents

Page

Foreword ... **iv**

Introduction ... **v**

1 Scope ... **1**
- 1.1 General ... 1
- 1.2 Exclusions ... 2
- 1.3 Areas not addressed ... 2

2 Conformance ... **2**

3 Normative references ... **3**

4 Terms and definitions ... **3**

5 Symbols and abbreviated terms ... **5**

6 Competency general framework ... **6**
- 6.1 Introduction ... 6
- 6.2 Information architecture view to support the management and exchange of competency information ... 7
- 6.3 Competency organization ... 9
- 6.4 Elements of competency ... 9
- 6.5 Semantic elements in competency expressions ... 10

7 Competency Semantic Information ... **11**
- 7.1 Architecture of competency information ... 11
- 7.2 Competency semantic information model ... 12
- 7.3 Types of Competency Semantic information - Competency Meaning Information ... 15
- 7.4 Types of Competency Semantic Information - Competency Situation Information ... 20

Annex A (informative) **Cases and relationships between ISO/IEC 20006 and ISO/IEC TR 24763** ... **23**

Annex B (informative) **Examples for competency information architectures** ... **26**

Annex C (informative) **Patterns of competency organization by HRMLs** ... **29**

Annex D (informative) **Previous use case on Japanese National Skills Standard (ETSS)** ... **31**

Annex E (informative) **Application to Japanese National Skills Standard (ITSS)** ... **32**

Annex F (informative) **Application to Canadian Learning Management System Desire2Learn** ... **34**

Annex G (informative) **Application to Canadian National Occupational Classification (NOC) and Canadian Nurses Association Canadian Nurse Practitioner Core Competency Framework** ... **40**

Bibliography ... **43**

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

ISO/IEC 20006 consists of the following parts, under the general title *Information technology for learning, education and training — Information model for competency*:

— *Part 1: Competency general framework and information model*

— *Part 2: Proficiency level information model*

— *Part 3: Guidelines for aggregation of competency information and data*

Introduction

From the late 1990s, some industrial and academic organizations have developed information technology standards in the skills and competency domain, such as human resources, on a global level to address the interoperability requirements and environmental complexities of management and sharing of competency information amongst different organizations. Some examples include work spearheaded by the following organizations: the IMS Global Learning Consortium Inc., HR-XML Consortium, IEEE-LTSC, OMG, CEN TC353 and also ISO/IEC JTC 1/SC 36 itself. Some typical problems encountered by stakeholders as well as ITLET systems dedicated to the management and exchange of competency information and where these issues may be encountered are provided in examples below:[2]

Example 1: Technical - Competency and associated information cannot always be selected and shared between different ITLET systems (e.g. learning management, HR, and other related platforms);

Example 2: Organizational - Competency and associated information is not easily used in human development activities, because skills and competency information may be detailed or expressed differently in various ITLET systems (e.g. learning management, HR, national occupational classification, and other related systems);

Example 3: Information exchange - Skills and competency proficiency information, such as individual status or degrees acquired, cannot be shared easily amongst different ITLET systems (e.g. HR, learning management, national occupational classification, and other related systems);

Example 4: Individual learner - Individual developmental learning, education, and training paths cannot easily migrate or be exchanged amongst ITLET systems;

Example 5: Systems perspective (where systems include individuals, organizations, and the technologies that support them) - Individuals and organizations cannot easily design and integrate informal and formal learning, education, and training opportunities to support life goals, career strategies, and career paths using existing common dimensions within ITLET systems;

Example 6: Practical analytics - The ability to access, extract, and analyse competency and associated information can provide evidence as to whether learning, education and training information needs are being met in order to analyse lifelong learning, thus where competency information must be drawn from different systems and where non-interoperable format and definitions are used;

Example 7: Assessment and evaluation - ITLET systems (e.g. acknowledgement and consideration are needed regarding evaluation biases in human assessment, the use of varying methods and metrics to evaluate human performance, and the need to conduct accurate skill gap analysis), where ITLET systems that use different competency digital schema are involved; and,

Example 8: Overarching goals and outcomes - Human assessment and support for the development of human potential requires ITLET systems that provide a more flexible, holistic integration and exchange of competency and associated information beyond individual learning opportunities, everyday operation, and work performance. Competency data must be generated.

Some of these identified problems have been addressed on a limited basis by the standards and specifications produced by the organizations mentioned above. Not only is it difficult to use these standards and specifications, however, but also the unsolved problems are still critical. It is still confusing for stakeholders to implement and use these standards and specifications. Also, various problems associated with ITLET related systems, which should be solved by or supported with information technology, still remain.

Currently, organizations, such as schools, universities, institutes, and companies, use different ITLET systems to support the use of learning content, to enable and enhance various learning activities, and to provide other services. To meet their mission and goals, such organizations may rely on in-house developers, others such as ITLET vendors or suppliers, or a combination of both to provide and operate IT systems to support LET. This means ITLET operations and other organizational systems that deal with skills and competency information, such as interrelated human resources (HR) information

systems, need to be interoperable to allow for communication between organizations, their employees, and outsourcing ITLET providers or suppliers.

The purpose of this multi-part International Standard is to provide a framework, models, system architecture used for competency and proficiency information, and a way to aggregate competency information. This standard will provide a general framework and information model to manage and exchange information about knowledge, skills, ability, attitude, and educational objectives. Especially this International Standard will focus on extending the concepts contained within ISO/IEC TR 24763 by providing more detailed information regarding competency information and its information aggregation. This multi-part standard may be used by software developers and implementers, instructional designers and test designers, and others to ensure that learning, education and training environments satisfy learners' and organizations' competency needs. In addition, this International Standard will provide definitions of several types of competency information aggregation, which will provide guidance for all stakeholders to better understand and support the development of interoperable systems that will enable competency information exchange.

Information technology for learning, education and training — Information model for competency —

Part 1: Competency general framework and information model

1 Scope

1.1 General

This part of ISO/IEC 20006 provides:

— a general framework for dealing with competency information in information technology for learning, education, and training (ITLET) contexts;

— a system architecture for managing and exchanging competency information and its related objects;

— an information model for expressing competency and its related objects that includes an introduction to the composition of competency;

— use cases used to support the development of the general framework and competency information model.

This standard is for those who design and use learning systems and human resources systems to support management and exchange of competency information using ITLET systems.

NOTE This International Standard is related to the Conceptual Reference Model developed in ISO/IEC TR 24763. Information regarding the relationships between the ISO/IEC 20006 and ISO/IEC TR 24763 is provided in this standard.

This multi-part International Standard also includes the following parts:

ISO/IEC 20006-2:—, *Information technology for learning, education and training – Information model for competency – Part 2: Proficiency level information model*, which provides

— information model for expressing semantics of competency proficiency and its levels, and

— use cases used to support the development of the competency proficiency level information model;

ISO/IEC TS 20006-3:—, *Information technology for learning, education and training – Information model for competency – Part 3: Guidelines for aggregation of competency information and data*, which provides

— guidelines and a data driven architecture for the development of specific data models managing aggregation of competency information and related objects,

— ways to aggregate competency information and its related object data, and

— use cases used to support the development of the guidelines for aggregation of competency information and competency data.[1)]

1) The terms competency information and competency data will be defined in ISO/IEC TS 20006-3.

1.2 Exclusions

The scope of this International Standard does not include an in-depth technical review of issues related to:

— adaptability to culture, language, and human functions;

— security;

— authentication;

— privacy;

— accessibility.

1.3 Areas not addressed

This International Standard currently does not address the following items:

— e-Profiles, which are a set of records that pertain to an individual (e.g. personnel records, student information system records);

— evidence information;

— assessment methods and metrics information

— ISO/IEC 20006 has been developed to support competency information and data management and exchange based on IT systems that are currently in use in Asia, Europe and North America. It is based on standardization that has occurred at transnational, national and regional levels in IT systems that are used to support human development including but not limited to:

  — university, college, secondary school curricula development;

  — learning activities supported by IT systems such as LMSs;

  — IT systems that support LET and Human Resources that are based on a National Occupational Classification system (e.g. learning activity development, job banks, etc.);

  — sector specific standardization in the area of IT and embedded skills;

  — IT systems that support LET and human resource quality management and development activities.

Further work may be needed to ensure that these standards support deeper IT integrations across various sectors and in other regions of the world.

It is anticipated that some or all of these requirements will be addressed in future editions of ISO/IEC 20006, or in companion International Standards, Technical Specifications and Technical Reports.

2 Conformance

The objective of this part of ISO/IEC 20006 is to support the management and exchange of competency information in a way that will promote interoperability and integration. To support competency management and development, competency information needs to be structured and described consistently to promote understanding, mutual communication and agreement.

The general framework and information model are based on the Conceptual Reference Model for Competency Information and Related Objects (CRM) (defined by ISO/IEC TR 24763). The CRM provides a toolkit that can be used to abstract and identify concepts used within IT systems to support the management and exchange of competency information across different HR, learning and training contexts. ISO/IEC 20006 builds upon the conceptual and abstract focus of ISO/IEC TR 24763 to

provide a general framework, information architecture, competency information model and additional components.

Competency information should be detailed in a way that is semantically robust and extensible. For the purposes of this standard, competency information is conformant with this International Standard if it adopts the information model and the element notations specified in this International Standard. (The element notations are defined in Clauses 6.4 – 6.5 and Clause 7).

A conforming notation may contain descriptions of meaning and context of competency information. In other words, it is intended to be extensible and may contain additional information elements of ISO/IEC TR 24763. For conformance to ISO/IEC TR 24763, classes for defining a competency in CRM competency are indicated with the following notation [E*n*] where *n* is a number that refers to a class defined in ISO/IEC TR 24763 to assist with understanding the linkages and relationships between the CRM and this standard. For example, as noted in ISO/IEC TR 24763, E1 = Action, E2 = Actor, E3 = Competency, and so on).

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 2382-36 (E/F), *Information technology — Vocabulary — Part 36: Learning, education and training*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382-36 and the following apply.

4.1
competency
ability of an actor to perform (a) necessary action(s) in (a) given context(s) to achieve (a) specific outcome(s)

[SOURCE: ISO/IEC TR 24763:2011, 2.2, modified — the words “observable or measurable” were deleted to allow for more general usage and application.]

4.2
competency aggregation
collection of *competency expressions* (4.4) that is in any structure

4.3
competency composition
unit and one of aggregation type that consists of definition and/or structured relationships of elements and attributes used to define contents of *competency* (4.1) as *competency expression* (4.4)

Note 1 to entry: For example, this may include information related to competency such as identification, semantics, context, and supplemental.

4.4
competency expression
any form of digitalized information regarding *competency representation* (4.7)

4.5
competency organization
digitized expression or map of aggregation type(s), that defines a designated unit as a set of *competencies* (4.1)

Note 1 to entry: This may include structured sub-competencies (e.g. competency information expressed as parent-child relationships). The form of competency organization structure is formulated as a tree structure or network structure with competencies.

Note 2 to entry: Competencies may be organized as competency definitions, competency frameworks, maps of aggregation type(s), and other forms of digitalized competency expressions.

4.6
competency package
standardized way to identify and exchange a set of data regarding *competency* (4.1) among different systems or application tools

Note 1 to entry: This standardized way may involve one of many aggregation types such as information regarding job, task, role and so on, in order to implement into LMS, HRIS, e-Profile, SIS and so on - because a competency may not only be expressed by competency content in practice, it also may be used with or by other information such as job, task, or role.

4.7
competency representation
image and idea of *competency* (4.1) that occurs in a human mind

Note 1 to entry: This is the real-world or portrayal or image or idea of competency as it is perceived by the human mind; whereas, the competency expression is the actual digital manifestation, notation, statement of competency. Representations include many different expressions.

4.8
conceptual reference model
common structure and definitions for describing the concepts and relationships within a system

[SOURCE: ISO/IEC TR 24763:2011, 2.8, modified.]

4.9
data model
graphical or lexical representation of data, specifying their properties, structure and inter-relationships

[SOURCE: ISO/IEC 11179-3:2003, 3.2.11, modified.]

4.10
framework
structure composed of related parts that are designed to support something

4.11
information model
expression of concepts, relationships, constraints, rules, and operations to specify data *semantics* (4.16) for a chosen domain of discourse

Note 1 to entry: An information model can provide sharable, stable, and organized structure of information requirements for the domain context.

4.12
information technology for learning, education and training system
ITLET system
set of one or more computers, devices, associated software, peripherals, terminals, human operations, physical processes, personal needs and preferences profiles, information transfer means, that form an autonomous whole, capable of performing information processing or information transfer to support learning, education or training

[SOURCE: ISO/IEC 14662:2010, 3.13, modified.]

4.13
method for competency assessment
instrument or tool to judge and/or to assess an acquired or demonstrated *competency* (4.1)

Note 1 to entry: Methods include physical methods and abstract or conceptual methods. There are various types of methods from the subjects of management science, pedagogy, psychology, engineering, statistics, biology and others.

Note 2 to entry: "Measurement method" is a generic description of a logical sequence of operations used in a measurement [ISO/IEC Guide 99:2007].

Note 3 to entry: This definition is associated with ISO/IEC 19796-3 [ISO/IEC 19796-3:2009].

4.14
metrics for competency assessment
material measure used to determine the value of specific aspects or characteristics of *competency* (4.1)

Note 1 to entry: In other words, it is done as a way of assigning a certain value using methods of measuring or testing in order to quantify a quality object from the standpoint of quality characteristics, such as scale, criterion, degree, weight, magnitude, interval, ratio, standard rate, or others.

Note 2 to entry: "Material measure" is defined as device reproducing or supplying, in a permanent manner during its use, quantities of given kinds, each with an assigned value [ISO/IEC Guide 99:2007].

Note 3 to entry: In ISO/IEC 15939:2002, the metric is defined as "the defined measurement methods and the measurement scale". However metric shall be clearly divided between the terms of method and scale to support implementation for audit assessment and evaluation.

Note 4 to entry: This definition is associated with ISO/IEC 19796-3 [ISO/IEC 19796-3:2009].

4.15
proficiency
<ITLET competency> level or degree of a *competency* (4.1) by judgment or measurement

Note 1 to entry: Proficiency can be used to ascertain or to identify progress, advancement or improvement in a competency, such as skill, knowledge, and other competency-related concepts.

4.16
semantics
branch of linguistic science that deals with the meanings of words

[SOURCE: ISO/IEC 11179-5:2005, 3.13]

5 Symbols and abbreviated terms

CIDA	Information Model for Competency – Guidelines for Competency Information and Data Aggregations
CMS	Content Management System
communi.	communication
HR	Human Resources
HRD	Human Resources Development
HRM	Human Resources Management
HRIS	Human Resources Information System
HRMLs	The Society for Human Resource – Markup Language

HR-XML	Human Resources - eXtensible Markup Language
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IMS	IMS Global Learning Consortium, Inc.
info	Information
IT	Information technology
ITLET	Information technology for learning, education and training
LET	Learning, Education and Training
LMS	Learning Management System
MLR	Metadata for Learning Resources
PLIM	Information Model for Competency – Proficiency Level Information Model
RCD	Reusable Competency Definition
RDCEO	Reusable Definition of Competency or Educational Objective
SIS	Student Information System

6 Competency general framework

6.1 Introduction

This international standard provides a general framework that supports the construction and management of information architectures, systems and database implementations for ITLET systems that are used to support the management and exchange competency information. This international standard enables the management and exchange of competency information by various types ITLET systems (e.g. learning management systems (LMS) and human resource management (HRM) systems (also known as personnel management systems), and planning for quality management of ITLET).

There are several aspects for implementation of competency information, this clause focuses on four aspects as noted below.

a) **Information architecture view:** There are many different types of information architecture that are used in these types of systems (see Clause 6.2). As noted in this clause, various information architectures are used not only in competency management applications, but also in other ITLET systems (e.g. learning management, HRM systems).

b) **Hierarchical and structural view:** Competency organization of this type of information also varies from system to system (see Clause 6.3). A competency may be structured in various ways and may have relationships to other competencies. A competency can be designed in a self-contained competency structure or as a part of a larger more complex competency structure.

c) **Element view:** For the element view within a competency (provided in Clause 6.4), competency information can be defined and specified by several compositions of standardized elements. This third aspect is the main target of this standard.

d) **Semantic view: This is a detailed view of element view focusing on competency semantics.** For the semantic view within a competency (provided in Clause 6.5), competency information has to include two semantic elements in competency expressions: the “competency meaning information” and the “competency situation information”.

6.2 Information architecture view to support the management and exchange of competency information

Competency information within IT systems may be configured in various ways and express many different relationships and concepts. Competency information either only title or detailed explanation is used in variety systems and application tools, such as e-Profile, LMS, HRIS, CMS and others (Figure 1). Depended on each system, competency information is implemented with variety ways and with other information into these systems. Simplest packaging way is to implement directly its system using only competency title label. The second simplest way is to implement directly its system using competency title label and some related information (see Appendix C case 1). Information regarding competency is implemented more and more, competency information may be managed with its specific data table or database system. Furthermore competency database system and/or competency management system are needed for complex information. These aggregation patterns to implement a set of competency information into systems and application tools are called competency package. It may be included data interface, URL or SQL in order to refer to other data table or database system using. It should be expressed to use competency information interoperability.

ITLET systems (such as LMSs and HRM systems) have to deal with competency label data. Whether the definition of a skill is clear or not, and also whether the definition exists or not, the data may need to be exchanged among many stakeholders, organizations and the other ITLET systems and applications. This competency related information should be consistent and well formed in implementations being used for managing and exchanging data. For the purpose of managing and exchanging, identifiable information elements, such as identifier, name, creator, etc. are indispensable to identify and exchange competency information amongst ITLET systems.

For these requirements, some industrial standard organizations were developed specifications for express competency information such like HR-XML competencies, RDCEO, RDC and so on. These packaged information are called sharable competency core information in this standard.

Some stakeholders and organizations require access to more detailed competency semantics, especially the individuals who want to use and produce further development of competency semantics, such as teachers, learners, instructional designers, HRD staff, learning content developers, and so on. More detailed information about competency semantics is useful to refer to and to understand what a competency is, not only to support and develop human understanding but also for intelligent information systems. Competency related objects as semantic entities can provide meaning and contextual information. These entities were indicated in ISO/IEC TR 24763.

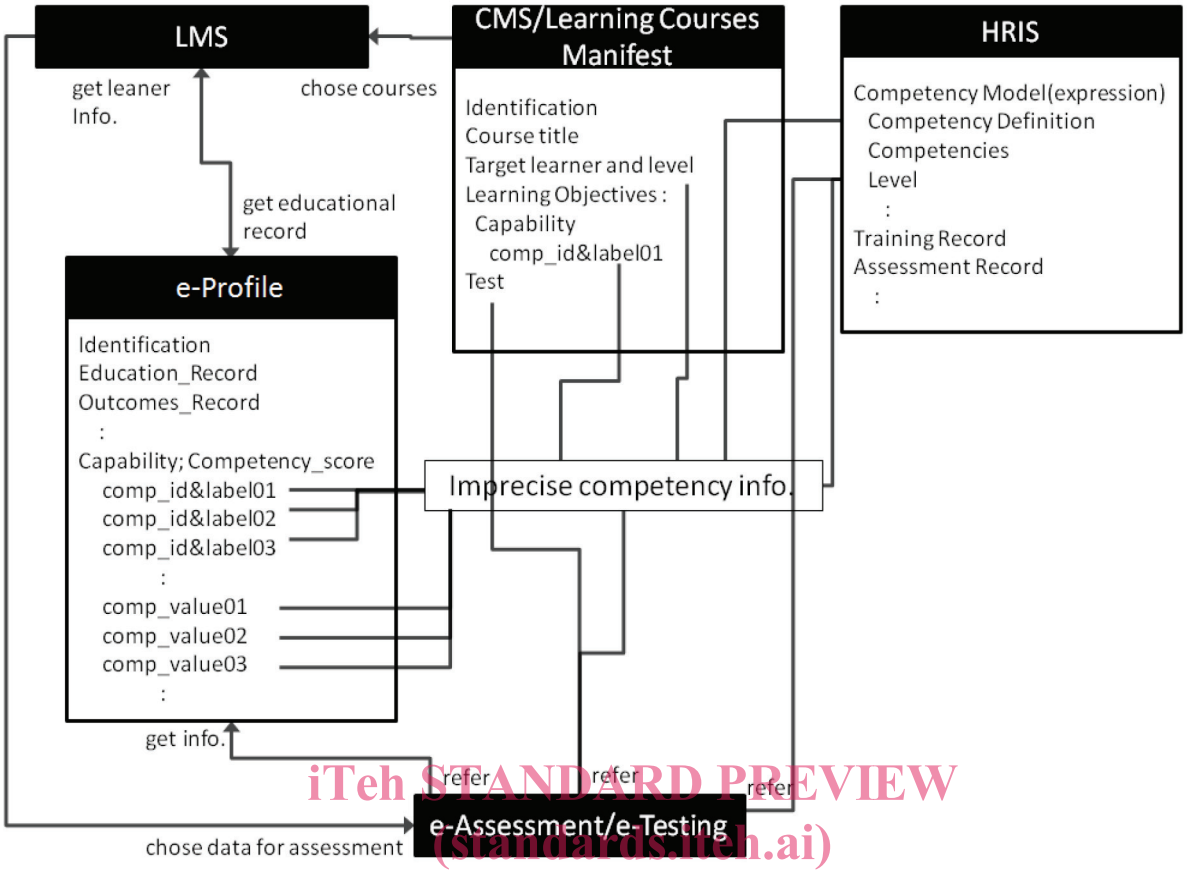

Figure 1 — Competency information amongst different systems

However these specifications did not guide the ways of expressing more detailed or more specific information with exchangeable and interoperability. Two more information entities for competency are needed, semantic information as extensions and competency proficiency level information as different conceptions (Figure 2).

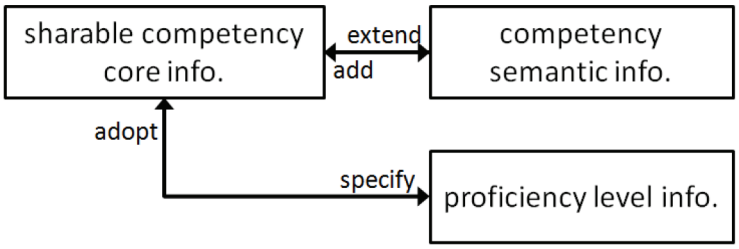

Figure 2 — Extensible expressions for competency information

Information architecture view includes a basic outline and data flows that need to be adaptable and flexible to accommodate connections to various IT systems in ways that make sense for the particular context. information architectures includes a basic outline and data flows. These are adaptable and flexible and can be changed in various IT systems for particular contexts. For example, in some systems connecting relationships designated by arrows may be present and in others some may be absent. Specific instances of the architecture including data flows may differ to accommodate specific requirements and contexts. The system architecture including data flows can be flexibly adapted to enable data transfer or integration of data flows into other systems, such as those used for job markets, resumes, learner assessment, etc."

This part of ISO/IEC 20006 mainly addresses and provides guidance regarding competency information and how it is organized (Clause 6.3), and the entity of "competency semantic information" (see Clause 6.5). In addition, an introduction to the relationships between this standard and the competency CRM (ISO/IEC TR 24763) is provided in sub Clause 6.4. It should be noted that ISO/IEC 20006-2 addresses the entity of "proficiency level information".

Additionally, in Clause 7 the difference between sharable competency core information and competency semantic information is clarified. Although the representation of competency concepts can be ambiguous in human communications, due to the way people view and construct competencies within ITLET systems, a certain competency information may exist in real systems as a particular type of data and may be labelled as something else. For example, a certain company set "communication skill" as one critical assessment dimension (factor) or as complex or composite learning objectives, then the term of "communication skill" may be used as a label that exists within the ITLET system and can be exchanged with other ITLET systems in the real world.

Annex A below presents examples for these cases that can be differentiated to describe how competency semantics might be implemented in and used by ITLET systems.

6.3 Competency organization

A set of competency, such as competency dictionaries, skills standards, or assessment dimensions can have different competency organization forms, such as a hierarchal structure (taxonomy), a natural language statement, and others. A structural complex or an organized competency can include multiple child or sub-competencies. For example, in the case of 21st. Century skills (The partnership for 21st century skills; US National organization)", the root competency title is "21st. Century skills" itself. Competencies on the second layer are "life and career skills", "learning and innovation skills" and so on. Then these second layers consist of the third levelled competencies at the lowest layer levels.

Lower level competencies in a hierarchy are sometimes defined by sub-competencies or other organized competencies. These parent-children relations and other relations among competencies are indicated within the semantics of each competency. These relationships provide rich context and meaning that is far more descriptive than a single competency label.

Parent-Children relationship may be organized several patterns, General-Specific relation, Whole-Parts relation, Universal-Particular relation. Abstract-Concrete relation, Level relation and others. Explanations for these patterns are indicated in Annex C, so this standard focuses on expressing competency information, not expressing competency organization directly. This standard is useful for building and using a competency information database or exchanging and managing competency information. This standard can be used to support a shared vocabulary regarding the types of relations that exist in the way that competency information is organized and to assist in efforts to exchange and manage this type of information.

6.4 Elements of competency

The main classes of this standard (based on the classes of the ITLET Conceptual Reference Model for Competency Information and Related Objects from the technical report ISO/IEC TR 24763) are provided below. Examples of subclasses for each class are given in the form of {a list}.

E1: [Action] {action related to learning, action related to teaching/training, action related to HR management, action related to HR administration, action related to LET administration...}

E2: [Actor] {person, group, automated agent...}

E3: [Competency] {simple competency, complex competency...}

E4: [Criteria and method] {performance criteria, method of measurement...}

E5: [Environment] {location description, duration, date and time, equipment...}

E6: [Evaluation, assessment process] {jury, exam, test...}