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BSI Standards Publication

Information technology — Learning, education and training — Competency models expressed in MLR

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National foreword

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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.

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) or the IEC list of patent declarations received (see http://patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

ISO/IEC 19788-1 provides metadata for learning resources (MLR) and consists of a set of data element concepts and conceptual domains (as defined in the ISO 11179 series) allowing the description of a conceptual level independently of any particular representation. This means that any educational metadata schema can be specified using MLR.

Schemas describing competencies are used in many information models related to learning, education and training, such as school transcripts, learning objectives, curricula descriptions, employer job requirements, professional association competency frameworks and national occupational classifications.

Therefore, with the development of the different parts of the ISO/IEC 19788 series and the increasing demand for information models' interoperability, the description of a "competency" in the MLR format appears as a necessity.

Use of MLR can support different types of approaches such as structured database, linked data and RDF models. This means that MLR can be used to describe objects that are used to support the development, identification, and evaluation of competencies within IT systems that use heterogeneous approaches and have varying forms, among which are included those proposed in ISO/IEC 20006-1[1] and ISO/IEC 20006-2[2].

This document provides a generic representation of a "competency" that will facilitate the exchange of information between systems using different data models to represent competencies, and the linkage of competency models to other metadata models.

This document can be used either alone or together with other standards to express and compare contextual views of schemas that describe competencies.

Relationship to ISO/IEC TR 24763

A "competency" is an item of discourse that refers to some entities of the real world. The meaning of this item of discourse as a "competency" description is given by fixed relationships between some classes of entities of the real world, which create a recognizable "competency pattern" independent of the description itself.

A tentative description of this pattern has been proposed in ISO/IEC TR 24763 as the "conceptual reference model for competencies and related objects". It aims to clarify the information types and relationships that are used within IT systems to support the description, management, development, transfer and assessment of competency information or other related objects.

The conceptual reference model (CRM), as outlined in ISO/IEC TR 24763, is further developed and refined in this document.

The main development of the CRM proposed in this document provides an abstract model of a "competency" and related entities that allows accounting for the meaning of any competency description in the real world. It is composed of:

1) a fixed structural model describing the competency world (i.e. the entities referred to in discourse about competencies and their relationships in context);

2) an open and extensible semantic structured layer attached to each of the competency world entities, allowing for the description of various aspects or dimensions or facets of an instance of the entity.

The two-level model

The fixed structural model describing the competency world is derived from the conceptual reference model for competency information and related objects published in ISO/IEC TR 24763.

The amended structural model of the competency world is presented in Figure 1.

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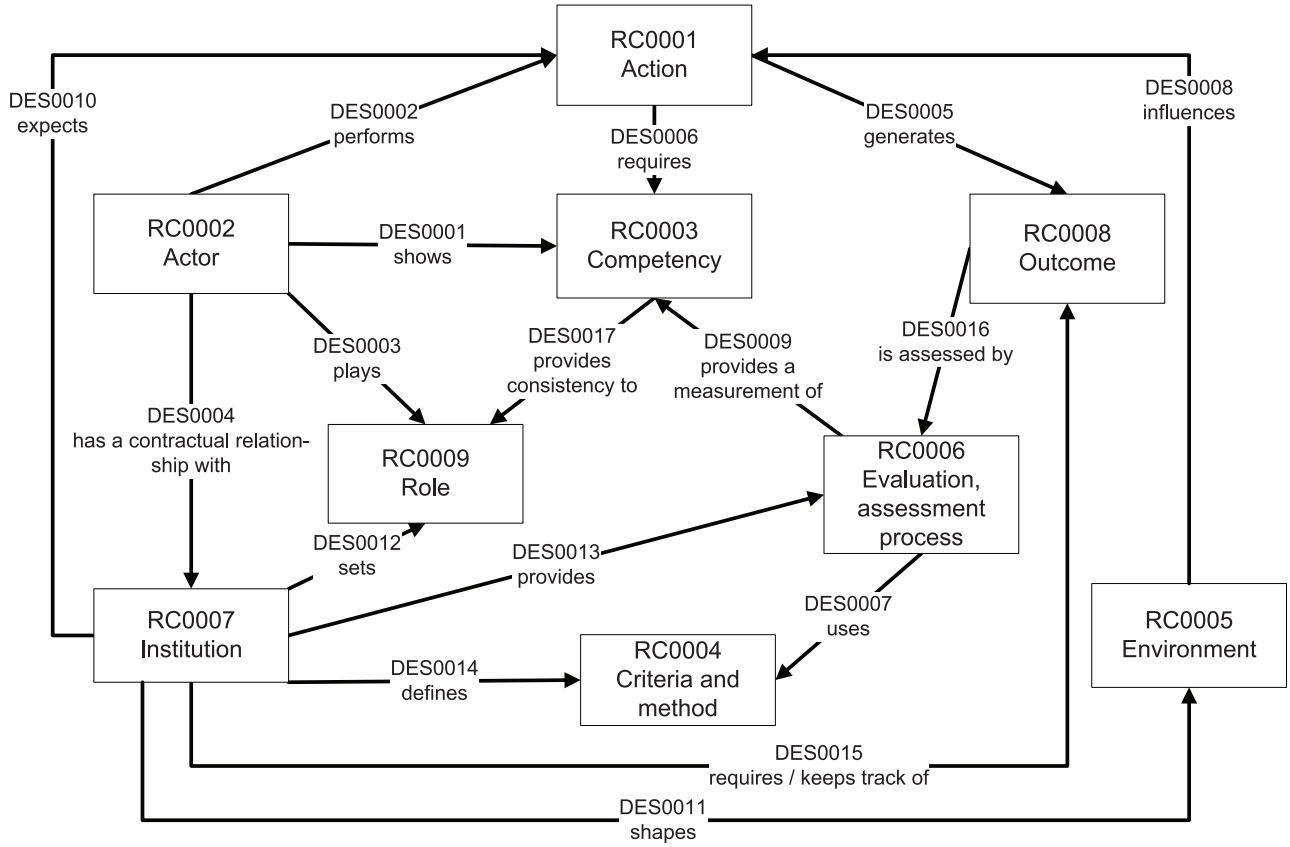

Figure 1 — Structural model describing the competency world (adapted from ISO/IEC TR 24763)

For semantic consistency, the following amendments have been made to the original model, concerning the names of classes and of properties.

— Classes

  — The linguistically neutral identifiers used in ISO/IEC TR 24763 are in the form "En", where "E" stands for "Entity", and "n" is a number. In this document, they are replaced by MLR identifiers "RCnnnn", where RC stands for Resource Class, and n is a number. As an example, E1 [Action] becomes *RC0001 Action*.

  — The class E7 initially named in English "*[LET Institution]*" has been replaced by its super-class "*RC0007 Institution*", which is more generic, and allows the extension of the structural model to any type of institutions, such as companies, which are de facto part of the "competency world".

— Properties

  — The linguistically neutral identifiers used in ISO/IEC TR 24763 are in the form "Pn", where "P" stands for "Property", and "n" is a number. In this document, they are replaced by the standards MLR identifiers "DESnnnn", where DES stands for "Data Element Specification", and n is a number. As an example, P1 *[shows]* becomes *DES0001 shows*.

  — The property P8 between E5 [Environment] and E1 [Action] initially named "*shapes*" has been renamed as "*DES0008 influences*" because it is semantically more appropriate.

  — The property P11 between E7 [Institution] and E5 [Environment], initially named "*influences*" has been renamed as "*DES0011 shapes*" because it is semantically more appropriate.

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— The property P17 between E9 [Role] and E3 [Competency] initially named *"profiles"* has been reversed and renamed as *"DES0017 provides consistency to"*. It has now *RC0003 Competency* as domain and *RC0009 Role* as codomain. The reason is also that it is semantically more appropriate.

Figure 2 represents the open and extensible semantic structured layer attached to each of the competency world entities. Figure 2 shows the generic data property diagram, linking any competency world entity to an MLR string, and the diagram of an example linking instances of a competency world entity to some of its descriptors.

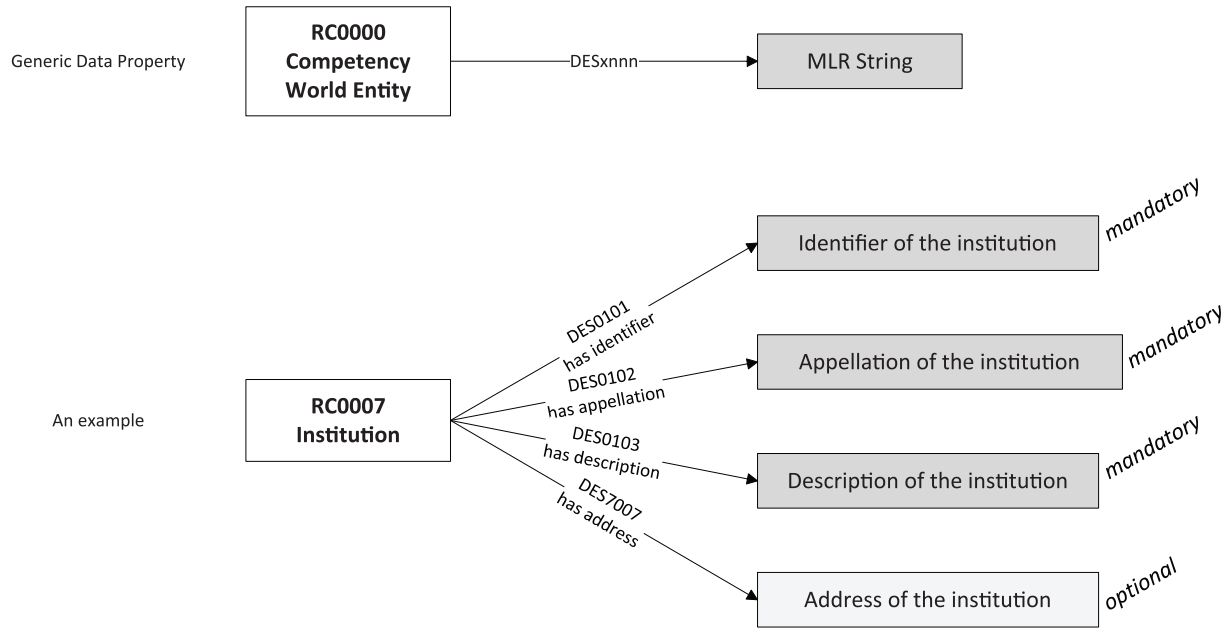

Figure 2 — Open and extensible semantic layer attached to a competency world entity (model and example)

This two-level modelling principle is used to describe a competency in MLR format. The structural model comprises 9 resource classes corresponding to 9 classes of entities in the real world and 17 pairs of properties (Data Element Specifications) corresponding to the relations between the instances of these entities in the real world. Together, they constitute the competency world model. This structural model is described in Clauses 5 and 6.

The semantic layer is attached to each of the 9 classes of entities by data properties, i.e. by properties having as domain an entity of the competency world and a codomain which is "literal". The mandatory data properties are described in Clause 7, together with how to build others.

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1 Scope

This document specifies the description of entities of the real world dealing with competencies, competencies description, competencies evaluation, and of the operations done by these entities on competencies.

This document provides a model to express all information required for the exchange and integration of heterogeneous descriptions of "competency" and of heterogeneous "competency objects":

— any item of discourse in the real world related to "competency" has a representation preserving its meaning in the proposed model;

— this representation allows comparison, hierarchical classification and aggregation of different items of discourse related to "competency".

The concrete content of items of discourse in the real world related to "competency" is not specified in this document, which only deals with the formal expression of the discourse.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 19788-1, *Information technology — Learning, education and training — Metadata for learning resources — Part 1: Framework*

ISO/IEC/TR 24763, *Information technology — Learning, education and training — Conceptual Reference Model for Competency Information and Related Objects*

3 Terms, definitions, abbreviated terms and symbols

For the purposes of this document, the terms, definitions, abbreviated terms and symbols given in ISO/IEC 19788-1, ISO/IEC TR 24763 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
appellation
designation of an object by a linguistic expression

Note 1 to entry: This term is more generic than Name (ISO/IEC 19788-1) but can be defined in exactly the same way.

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3.2
competency
observable or measurable ability of an actor to perform necessary action(s) in given context(s) to achieve specific outcome(s)

Note 1 to entry: Adapted from ISO/IEC TR 24763:2011, 2.2.

4 Content value rules

This clause lists rule sets defined in ISO/IEC 19788-1 that may be reused in this document (see Clause 7) or in order to apply it.

MLR String

See ISO/IEC 19788-1:2011, subclause 9.2.

Date

See ISO/IEC 19788-1:2011, subclause 9.3.

Date & Time

See ISO/IEC 19788-1:2011, subclause 9.4.

Duration

See ISO/IEC 19788-1:2011, subclause 9.5.

IRI

Rules for the representation of Internationalized Resource Identifiers (IRI).

ID: PRS0006 Name: IRI	
Rule_ID	Rule statement / Example(s) & Note(s)
01	A character string constructed according to RFC 3987

HTTP IRI

ID: PRS0007 Name: HTTP_IRI	
Rule_ID	Rule statement / Example(s) & Note(s)
01	A character string constructed according to RFC 3987 and using the HTTP Scheme

5 The competency world entities

In this clause, the entities of the competency world are described using the MLR format as resource classes. All these entities have specific properties relating them to other entities of the competency world which are not data properties, i.e. which have another competency world entity as codomain, as shown in Figure 1.

These entities are considered as subclasses of the superclass *competency world entity*, so that they inherit its data properties, which are described in Clause 7. Each entity has the following attributes.

— **Resource class identifier** (an identifier identifying the latest version of the resource class description), mandatory

— **Resource class canonical identifier** (a canonical identifier for the resource class), mandatory

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— **A Resource class name** (a name for the resource class, linguistically neutral, readable by machines), mandatory

— **A Resource class label** (a label for the resource class, in a given language, readable by humans), mandatory

— **Definition** (a definition for the class), mandatory

— **SubclassOf** [multiple inheritance] (a superclass for the class under specification); a class can inherit behaviours and features from more than one superclass), optional

— **Note** (additional information and examples), optional

RC0000 competency world entity

Resource Class identifier	ISO_IEC_22602:2019::RC0000
Resource Class canonical identifier	ISO_IEC_22602::RC0000
Resource Class name	Competency_World_Entity
Resource Class label	Competency World Entity
Definition	An instance of this class is a real-world entity which belongs to one of the classes of the structural model of the competency world.
SubclassOf	—
Note	There are nine competency world entities numbered RC0001 to RC0009, which are presented in Figure 1 and described below.

RC0001 Action

Resource Class identifier	ISO_IEC_22602:2019::RC0001
Resource Class canonical identifier	ISO_IEC_22602::RC0001
Resource Class name	Action
Resource Class label	Action
Definition	An instance of this class is an act in the real world, which generates changes in the state of one or more entities.
SubclassOf	ISO_IEC_22602::RC0000
Note	Usually, an action is semantically represented by an action verb followed by an object to which it applies. Examples: to write a paper to play a symphony to build a bridge

RC0002 Actor

Resource Class identifier	ISO_IEC_22602:2019::RC0002
Resource Class canonical identifier	ISO_IEC_22602::RC0002
Resource Class name	Actor
Resource Class label	Actor

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Definition	An instance of this class is a person or group of people or automated agents who have the potential to perform an action.
SubclassOf	ISO_IEC_22602::RC0000
Note	Usually, an actor is semantically represented by the subject of an action verb. Examples: the entity designated by the name "Arthur Cravan" the entity designated by "The Paris Symphony Orchestra" the entity designated by "GG Engineering"

RC0003 Competency

Resource Class identifier	ISO_IEC_22602:2019::RC0003
Resource Class canonical identifier	ISO_IEC_22602::RC0003
Resource Class name	Competency
Resource Class label	Competency
Definition	An instance of this class is an ability of an actor to perform an action on an entity in a given environment to achieve specific outcome.
SubclassOf	ISO_IEC_22602::RC0000
Note	Very often, "is able" denoting the abilities or the word "ability" is omitted in the description, and a competency is described as an action followed by the generated outcome. Examples: (ability) to synthetize the main trends in the domain (the orchestra is able) to play Beethoven's 5th Symphony in the Concert Hall superlatively well (GG Engineers are able) to apply structural engineering principles and techniques

RC0004 Criteria and method

Resource Class identifier	ISO_IEC_22602:2019::RC0004
Resource Class canonical identifier	ISO_IEC_22602::RC0004
Resource Class name	Criteria_and_method
Resource Class label	Criteria and method
Definition	An instance of this class is a criterion or a set of criteria to assess outcomes of an action or a method or a set of methods to provide a measurement of a competency, through an evaluation, assessment process.
SubclassOf	ISO_IEC_22602::RC0000

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Note	Criteria and method can be quantitative or qualitative, as well as a mixture of both quantitative and qualitative. Quantitative methods usually require a measuring instrument, whereas qualitative methods are based on a judgement. Examples: quantitative criterion to evaluate a paper: up to 10 points for the ideas, 5 points for the style, and 5 points for the spelling qualitative criterion: a standing ovation is the highest mark of appraisal of a concert quantitative method: measurement of bridge resistance through a 20-ton load test

RC0005 Environment

Resource Class identifier	ISO_IEC_22602:2019::RC0005
Resource Class canonical identifier	ISO_IEC_22602::RC0005
Resource Class name	Environment
Resource Class label	Environment
Definition	An instance of this class is any physical or virtual entity or set of physical or virtual entities composing the surroundings of an action.
SubclassOf	ISO_IEC_22602::RC0000
Note	The instances of this entity influence the way an action is performed by an actor. Examples: the student's computer running an Operating System and Software the Olympia Concert Hall the Thames River in the central part of the City

RC0006 Evaluation, assessment process

Resource Class identifier	ISO_IEC_22602:2019::RC0006
Resource Class canonical identifier	ISO_IEC_22602::RC0006
Resource Class name	Evaluation_assessment_process
Resource Class label	Evaluation, assessment process
Definition	An instance of this class is an evaluation process or assessment process used to assess outcomes, i.e. the results of actions.
SubclassOf	ISO_IEC_22602::RC0000
Note	If there is a validated scale of performance level associated with the criteria used by the process, then this process provides a measurement of a competency. Examples: students essays are reviewed according to a given Rubrics grid the performance of the orchestra is appreciated by a jury the resistance of the bridge is tested by the successful crossing of an automated 20-ton truck

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RC0007 Institution

Resource Class identifier	ISO_IEC_22602:2019::RC0007
Resource Class canonical identifier	ISO_IEC_22602::RC0007
Resource Class name	Institution
Resource Class label	Institution
Definition	An instance of this class is any legal entity that is likely to expect an actor with whom it has contractual relationship to play a specific role and to perform specific actions described in the contract.
SubclassOf	ISO_IEC_22602::RC0000
Note	Examples: the entity named University of Toronto the entity named Théâtre des Champs-Elysées the entity named London City Council

RC0008 Outcome

Resource Class identifier	ISO_IEC_22602:2019::RC0008
Resource Class canonical identifier	ISO_IEC_22602::RC0008
Resource Class name	Outcome
Resource Class label	Outcome
Definition	An instance of this class is an observable or measurable result of an action.
SubclassOf	ISO_IEC_22602::RC0000
Note	Types and levels of outcome for each action are tacitly agreed by an actor and an institution within their contractual relationship. Examples: the paper is written by the student on a computer without spelling errors Beethoven's 5th Symphony is played by the orchestra in the Concert Hall the wooden bridge across the river is built in less than one week

RC0009 Role

Resource Class identifier	ISO_IEC_22602:2019::RC0009
Resource Class canonical identifier	ISO_IEC_22602::RC0009
Resource Class name	Role
Resource Class label	Role
Definition	An instance of this class is any functional position within an institution that an actor in contractual relationship with it is entitled to occupy.
SubclassOf	ISO_IEC_22602::RC0000

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Note	Each position is associated with a set of expected competencies, which provides consistency to the instances of role and make the credibility of the player (an actor) for the others. Examples: student first violin project manager

6 Competency world properties (object properties)

In this clause, the relations between the entities of the competency world are described using the MLR format as data element specification.

All the properties defined between two competency world entities can be defined in two ways, i.e. each property has a reverse property, which uses as domain the codomain of the first one, and as codomain the domain of the first one. Both properties are described in this document. They are numbered from 1 to 17 from the direction described in Figure 1, and from 21 to 37 for the reverse properties.

Each property has the following attributes.

— **Property identifier** (data element specification identifier, identifying the latest version of the data element specification), mandatory

— **Property canonical identifier** (data element canonical identifier), mandatory

— **Property name** (data element name, linguistically neutral, readable by machines), mandatory

— **Property label** (data element label, in a given language, readable by humans), mandatory

— **Definition** (data element definition), mandatory

— **Linguistic indicator** (data element linguistic indicator), mandatory

— **Domain** (data element domain), mandatory

— **Codomain** (data element codomain), mandatory

— **Content value rules**, conditional

— **Refines**, conditional

— **Example(s)**, optional

— **Note(s)**, optional

DES0001 shows

Data Element Specification	
Property identifier	ISO_IEC_22602:2019::DES0001
Property canonical identifier	ISO_IEC_22602::DES0001
Data element attributes	
Property name	shows
Property label	shows
Definition	Association of an actor to the demonstration of a competency through behaviour or achievement.
Linguistic indicator	—
Domain	Actor (ISO_IEC_22602::RC0002)

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Data Element Specification	
Codomain	Competency (ISO_IEC_22602::RC0003)
Content value rules	—
Refines	
Example(s)	
Note(s)	If DES0001 is true, then competency has been demonstrated through an instance of action that has generated instances of outcome and these instances have been assessed by an instance of evaluation and assessment process providing a measurement of competency, which reaches at least the level considered as meeting the minimum requirements by criteria and method defined by an institution.

DES0002 performs

Data Element Specification	
Property identifier	ISO_IEC_22602:2019::DES0002
Property canonical identifier	ISO_IEC_22602::DES0002
Data element attributes	
Property name	performs
Property label	performs
Definition	Association of an actor to a future, ongoing or past action.
Linguistic indicator	—
Domain	Actor (ISO_IEC_22602::RC0002)
Codomain	Action (ISO_IEC_22602::RC0001)
Content value rules	—
Refines	
Example(s)	
Note(s)	The canonical form of this property uses the generic verb “perform” followed by the gerundive of the action verb followed by the object to which the verb applies. But generally, this property uses, as a shortcut, the action verb, so that it can take many different forms, which can be considered as sub-properties.

DES0003 plays

Data Element Specification	
Property Identifier	ISO_IEC_22602:2019::DES0003
Property canonical identifier	ISO_IEC_22602::DES0003
Data element attributes	
Property name	plays
Property label	plays
Definition	Association between an actor and a role.
Linguistic indicator	—
Domain	Actor (ISO_IEC_22602::RC0002)
Codomain	Role (ISO_IEC_22602::RC0009)
Content value rules	—
Refines	
Example(s)	

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