Chapter 2
Interoperable Assessment Based on Competency Modelling

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ABSTRACT
The aim of this chapter is to illustrate some affordances of machine-processable competency statements. Such competency statements are supported by ontologies and taxonomies of competency. Machine processing can offer interoperable and reusable resources and applications that are pedagogically effective for e-learning and assessment. A competency statement which can be read, processed, and interpreted by machine contributes to the automatic generation of questions and offers a semantic structure using the Web Ontology Language (OWL) to express competencies for further processing. The generated questions are expressed in the IMS Question and Test Interoperability specification (IMS QTI) to enable interoperability.

COMPETENCY MODELLING, ONTOLOGIES, AND IMS QTI
The use of competency modelling, ontologies, and IMS QTI overcomes limitations of interoperability, portability, and reusability in assessment. Competency modelling supports consistency checking, assessing differences in knowledge levels, and comparing achievement in related domains, which were essentially impractical previously. Using ontologies and Semantic Web technologies addresses many of the problems of extending and combining structured content in different formats from different schemas. The IMS QTI specification facilitates the sharing of questions and tests, enabling investment in the development of common tools such as Web-based authoring and delivery applications.

A competency model has the great advantage of providing a machine-processable shared understanding of a domain. The model supports consistency checking, assessing differences in knowledge levels, and comparing achievement in related domains, which were essentially imprac-
tical previously. The issue of how to represent competency as a rich data structure is focused on supporting collaboration between different communities and the tracking of the knowledge state of the learner. The same competencies may appear in more than one place in the competency hierarchy. Thus, it makes sense to capture the data model of those competencies in some reusable form, so they have to be defined only once. It is suggested that information about competencies should form the basis of pedagogically-informed metadata which would be relevant to any description of content or process in a learning and teaching situation.

Ontologies support connecting resources available in a domain and representing knowledge states of students. Ontological metadata expresses terms defined formally and unambiguously. This metadata provides information for e-assessment in supporting the integration and reuse of these data with other systems, and for adaptive assessment systems in supporting the adaptation of their behaviour and structure. Structuring knowledge in a new domain by using ontological conceptualization should allow the faster build of new systems.

The proposed competency model, named COMpetence-Based learner knowledge for personalized Assessment (COMBA), has been developed because of the unsatisfactory results delivered by existing competency standards and desired taxonomies of competence. This model reflects all relevant features of the learner’s behaviour and their knowledge, skills, and attitudes that affect their learning and performance. Statements of competency are machine-readable. Machine processing can offer interoperable and reusable resources and applications that are pedagogically effective for e-learning and assessment. A competency statement which can be read, processed, and interpreted by machine contributes to the automatic generation of questions, distractors, feedback, and question sequences, and offers a semantic structure for further processing. The use of a competency model allows the recording of the achieved competencies of learners, and provides an integration of the system proposed here with adaptive assessment.

THE DEVELOPMENT OF COMPETENCY MODELS

A competency may be considered to be based on subject matter knowledge and skill, contextualized with respect to particular situations or scenarios (Harzallah, Berio and Vernadat, 2006). Competencies may be assembled and linked in a rich data structures. A competency may appear in more than one place in a competencies hierarchy. Thus, it makes sense to capture the data model of competencies in some reusable form, so they have to be defined only once.

The possible requirements for describing competencies based on an analysis of the general structure of existing competency standards and competency ontologies (Trichet and Leclère, 2003; Draganidis and Mentzas, 2006; Schmidt and Kunzmann, 2006) are listed below. The list is general and captures the type of information modelled in existing standards, rather than defining a canonical set of properties.

- **Description**: the general description of the competency.
- **Type**: type of trait that represents an aspect of the competency such as knowledge, skill, attitude, and so on.
- **Relationship**: relationship to other competencies such as “part-of”, “child competency”, and “parent competency”.
- **Proficiency level**: a measurement of the degree to which the competency has been achieved.
- **Measurement scale**: a scale that relates to proficiency level and weight.
- **Taxonomy**: a taxonomy reference for structuring competency data.
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