Extension of IMS LD for improved pedagogical expressiveness in assessment

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ABSTRACT

The IMS Learning Design specification (LD) was introduced in order to describe any learning and teaching scenario in a formal way. Its high level of generality, however, may make it difficult for teachers and instructional designers to apply it to their learning and teaching scenarios, particularly to assessment, both formative and summative. This limitation suggests the need to explicitly separate and identify the roles of learner and teacher, to identify more carefully the teaching activities of evaluation, marking, and feedback, and to integrate more fully the achievement of learning objectives into learning activities. The paper suggests an expanded IMS LD model to make learning and teaching components more explicit. By defining relevant data and structures such as competence, evaluation, artefact, and feedback, the benefits and impacts of an improved model include reuse of learning content, automated processes for metadata creation and search, additional detail to the participating teacher and learner descriptions, increased granularity for such descriptions, and greater precision in modelling the learning and teaching process.

Introduction

The IMS Learning Design specification (IMS LD) is based on a well-founded conceptual model, an information model, and a behavioural model with the diversity of concepts existing in a wide range of pedagogic techniques (IMS LD, 2003). Though IMS LD provides a framework of elements that can describe any design of a learning and teaching process in a formal way, it is insufficient in modeling certain important details of learning and teaching activities. We observe that the high level of abstraction of IMS LD allows it to model a business process such as a mortgage application just as well as it can model a tutorial.

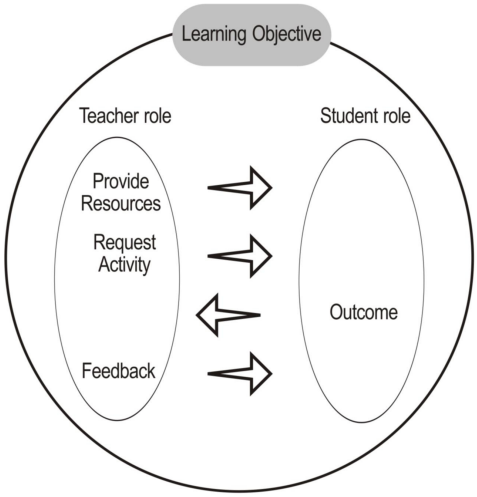

Figure 1 Model of the learning transaction

Error! Reference source not found. illustrates the 'Learning Transaction' (Gilbert *et al.*, 2005) which identifies the essential components of any learning and teaching situation, with terminology modified for consistency with IMS LD notation.

This suggests that the modeling of learning and teaching situations in IMS LD requires more specificity and appropriate detail. In particular, the characteristic activity of the teacher role when processing assessments as a marker or assessor and as a provider of feedback is not explicitly integrated. For example, IMS LD has no means to specify how the actors of roles interact within each learning activity, and can only approach this by using optional descriptive elements. For this reason, research around limitations and extensions over the current IMS LD specification is gaining more attention in order to improve it.

Caeiro, Anido and Llamas (2003) suggested a modification and extension of the specification in the activity and method parts using Activity Theory (AT) and Workflow Management Systems (WFMS) in order to provide more flexibility and modularity in the description of learning designs. We take up this suggestion by explicitly separating the roles of learner and teacher.

Hernández-Leo, Asensio-Pérez and Dimitriadis (2005) proposed an extension to the IMS LD service description, consisting of the definition of a special type of service to support collaborative learning activities. However, this extension still has some limitations as it does not allow the specification of privileged roles, among others.

Miao *et al.* .(2005) discussed the major limitations for modeling collaborative learning processes and proposed five core elements: roles, activities, transitions, artefacts, and environments within a Computer-support collaborative learning (CSCL) scripting language. We take up their differentiation of teaching activities, and also add a differentiation of outcomes.

Most extensions are focused on collaborative learning activities, and do not address improving pedagogical learning and teaching activities. There are other initiatives to overcome such limitations for those situations such as the semantic web. The semantic web provides a language that expresses both data and rules for reasoning about data, and that allows rules from any existing knowledge-representation system to be exported to the web.

Amorim *et al.* (2006) and Sánchez *et al.* (2008) presented an ontology to represent the semantics of IMS LD using a taxonomy of concepts and a set of formally defined axioms. However, the XML-Schema language is not expressive enough to represent all the knowledge compiled in the models of the IMS LD specification. Our approach therefore is to continue developing the IMS LD conceptual model.

In this paper, we have focused our attention on the elements used by IMS LD to describe the different parts involved in a learning design. The paper presents limitations of IMS LD that we have found in the way IMS LD elements are described and structured. Finally, the proposed extension of IMS LD is discussed and the main contributions are summarized.

Limitations of IMS LD

The IMS LD specification is able to express various pedagogical approaches, as well as ensuring that content can be adapted to personal needs and assessments can be integrated (Van Es and Koper, 2006). IMS LD provides a flexible conceptual model by using relatively unstructured textual definitions. This high level of generality may

mislead instructional designers in applying learning and teaching activities and may make it difficult for teachers to recognise and apply IMS LD to their teaching activities. This paper proposes a development of IMS LD to make the learning and teaching components more explicit. We address the following elements in IMS LD to improve its pedagogical expressiveness.

Learning Objective and Prerequisite

A learning and teaching process can only take place when there are meaningful learning activities performed by the learner, and this implies that learning objectives are required and are not optional (Chew, 2005). And, assessment of learner achievement is necessarily by reference to the intended learning objectives or outcomes. Such learning objectives can be formulated by teachers using their own principles of learning. They require considerable thought to write. While the IMS LD specification allows a means for defining diverse learning designs, the unstructured and optional textual definition of learning objectives does not integrate such significant components as a necessary part of the design. It also makes the connection of an assessment to its associated learning objectives more or less impractical. This is currently a problem in IMS LD because the required learning objectives and prerequisites are not amenable to machine processing.

Activity and Role

Activities are carried out by the roles that participate in these activities as instances of "learner" and "staff". The specification does not assign directly an activity for each role. In the real situation of a learning and teaching process, the learner role always performs an educational activity within a learning activity concept that establishes a relation with the prerequisites and the intended learning outcomes (Gagne *et al.*, 1992). This reality is not fully reflected in IMS LD since there is no necessary connection between the activity as a learning activity and the intended learning outcomes or educational objectives which it addresses. The "support activity" is introduced to facilitate the execution of a learning activity. An instance of the support activity is performed by a staff role. However, this generalization does not reflect the crucially important role of the teacher in evaluating the learner's activity and in providing appropriate feedback. If IMS LD defines more specific activity for each role, this would help teachers and instructional designers to better align their designs with established pedagogical requirements. In particular, it would help identify the place, structure, and process of assessment (asking a question, evaluating or marking the answer, providing feedback) within a so-called "unit of learning".

Environment

Environment describes the educational resources to be used in the activities. Assessment is part of the developmental process of learning (Kommers *et al.*, 1996) and is related to the accomplishment of learning outcomes. Although assessments in IMS LD can be treated as simple learning objects, it is worth defining them as necessary parts in the environment concept in order to support learning outcomes in learning and teaching designs.

Proposed extensions to IMS LD

We propose one new component for the IMS LD model, competence (black box in Figure 2); four developed components (medium grey), feedback, artefact,

assessment, and evaluation; and three differentiated components (light grey), resource, learner role, and teacher role.

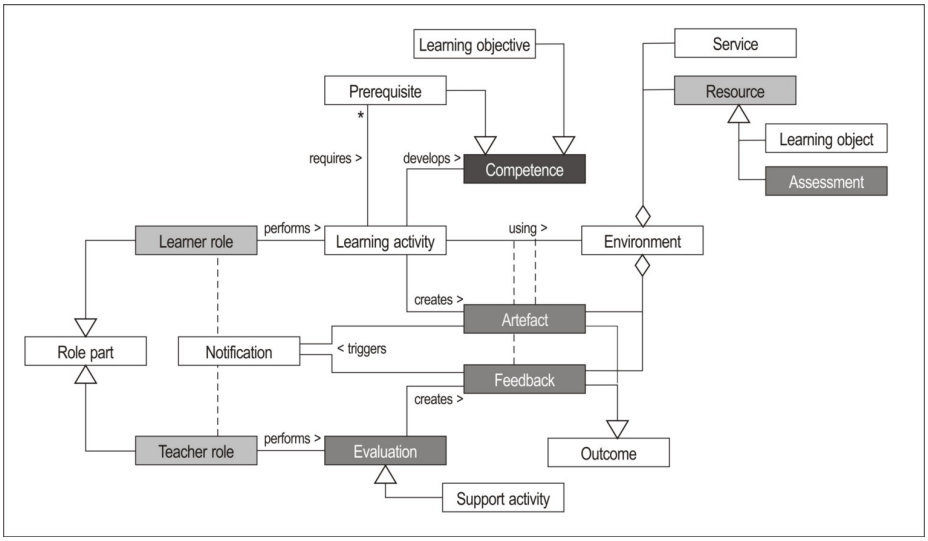

Figure 2 Developed and differentiated IMS LD conceptual model

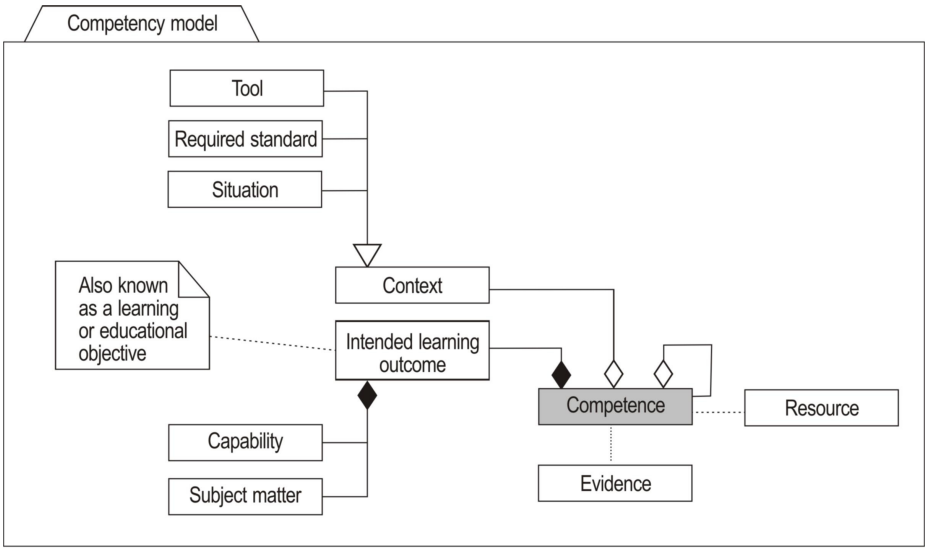

Figure 3 Competence model

The achievement of learning objectives indicates a learner's competences. A competence provides a rich data structure for description, comprehensive reference, and exchange, to support a learner's competence profile. This requires modelling the learning objectives to identify and integrate appropriate learned capability and subject matter knowledge within the broader teaching and learning context of unit, course, and programme. The improved competence model is represented in Figure 3 (Sitthisak *et al.*, 2008).

A competence involves a capability associated with subject matter content and optionally a contextualisation (the situation or scenario, tools, and standard of performance). A competence can be linked to one or more resources, and a student may evidence a competence in one or more ways.

Capability is behaviour that can be observed, based on a domain taxonomy of learning such as Bloom's (Bloom and Krathwohl, 1956), Gagné's Nine Areas of Skill (Gagne, 1970), or Merrill's Cognitive Domain (Merrill, 1999). Subject matter content

is the subject domain of what the student can do by the end of course. The competence evidence substantiates the existence, sufficiency, or level of the competence, and might include test results, reports, evaluation, certificates, or licenses. External knowledge resources and tools support and promote the problem solving, activity performance, or situation handling of the competence. The situation identifies the particular circumstances and conditions of the competence, for example, its time limit. The proposed competence model involves three important principles: an orientation towards, and focus upon, activity-based teaching and learning; the identification and integration of appropriate subject matter content within a broader teaching and learning context, represented by a hierarchy of linked competences; and the identification of the assessment that would demonstrate successful teaching and learning has been accomplished. The domain subject matter content, capability taxonomy, and competence may be represented in the form of an ontology based on the Simple Knowledge Organisation System (SKOS) (W3C, 2005; Sitthisak *et al.*, 2009).

Learning objective and prerequisite elements can be described by the *competence* element in order to provide a containment framework. The learning activity will be based on a given competence. The prerequisites will now be able to be expressed as competences which should already be possessed by the learner.

Building learning activities requires identifying the scenarios that will be proposed by the teachers, the different tasks for learners to perform, and the different roles to be distributed. A role is used to distinguish users who have different privileges and obligations in the processes. So a *learner role* element should perform a learning activity element, while a *teacher role* should perform explicitly pedagogical activities related to that role.

The relevant activity for the teacher role may be expressed as *evaluation* which is a type of a support activity. Evaluation, otherwise called "marking", permits the critical assessment of a learner's achievement as evidenced by the outcome (an artefact) of the learner's activity. This can provide *feedback* and motivation for continued improvement for learners and teachers. To ensure that learners are supported in their learning, the outcome of the teaching evaluation is a feedback element. Hence, the generalised outcome of activity in IMS LD is now differentiated as either feedback or artefact. An *artefact* may be created and shared in and/or across activities as an intermediate product and/or a final outcome.

Finally, we propose *assessment* as a type of *resource* in an environment element in order to encapsulate the aspects of assessment for learning and teaching. The identification of the assessment would demonstrate successful teaching and learning that has been accomplished. One of main challenges in formative assessment is creating effective feedback. Effective feedback needs to provide information that helps students self-correct and helps clarify what good performance is. A competence hierarchy would allow the generation of feedback derived from nodes semantically close to 'incorrect' nodes in the hierarchy. Feedback could relate to the concepts of the incorrect answer, as well as maintain consistency with the key concept of the question.

Benefits and Impacts

Learning activities aim at developing a learner's competence, and there are consequent processes of seeking and interpreting evidence to decide where the learners are in their learning (so-called "positioning"), where they want to go, and

how they can get there. In order to support these activities and objectives, typically mediated by formative and summative assessments, appropriate data and metadata content and structure are required for storing, organising, and sharing pedagogically-related data. The benefits of these proposed extensions to IMS LD are expected to enable search, comparison, gap analysis, recommendation, and visualising of learning objects, learning resources, and teaching assets. While this may promote reuse of learning content, automated processes for metadata creation and search are required so that these burdens can be alleviated by machines (Al-Khalifa and Davis, 2006).

The design of an environment requires both the definition of the learning activity as well as that of the support activity (Gounon *et al.*, 2006). The proposed model assists and guides the learning activity description in association with the teaching activity which supports the learning activity. The purpose of this model is to describe the learning and teaching structures that the instructional designer wishes to create. The model becomes the basis for reflection upon the desired accompaniment in a given learning activity and the description of the teaching structures in an e-learning platform. In this model, we detail which role carries out which activity and when in order to improve the accompaniment by sharpening the description in terms of role activities and roles. This enables adding a level of detail to the participating tutor and learner's description and increasing the granularity for such description.

Refining the main activities introduces more precision in the different steps in learning and teaching processes by defining relevant data and structures such as competence, evaluation, artefact, and feedback. In particular, the elaborated resources definition denotes the service and the material resources required for assessment, and the refinements as explicitly providing for the essential teacher activities of marking and feedback. This model can now be seen as a planning tool which will allow learning activities and assessments to be defined in greater detail and shared between teachers and learners. Instructional designers can also use the proposed model to state all the information required for setting up learning activities and assessments.

Conclusion

In this paper we have proposed several changes over the current IMS LD specification in order to provide more pedagogically appropriate elements in the description of learning designs. In particular, we have found that a focus on assessment has revealed the need for explicit elements concerned with intended learning objectives and competences and with teacher role activities of evaluation (marking) and feedback. Our ideas improve the description of learning designs without introducing too much complexity. We are interested in the IMS LD specification in order to have a containment framework of elements that can describe any design of a learning and teaching process in a formal and machine processable way. Instructional designers could use this model to describe the activities that should be carried out in a learning process without being constrained by any particular pedagogy.

We have been developing ontologies for competence models using OWL-Lite (Sitthisak *et al.*, 2008). The model has the great advantage of providing individuals with a more detailed identification of students' performance. The model could be used in conjunction with a development discussion between the student and teacher to provide focus on the key aspects to be developed for each competence. It is

suggested that information about competences 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. Further work is needed to develop a prototype based on the proposed IMS LD model. There are currently tools for implementing IMS LD including Reload (Reload, 2006) and Copper Core (Copper Core, 2005). These tools allow users to design and execute a Unit of Learning. However, the main drawback of our proposal is that these software programs will need to be modified in order to include the suggested developments.

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