Standardisation in Web-based Learning

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Abstract

Web-based learning or eLearning is expected to be the "killer application" of the internet that is going to affect our lives in significant ways as we transition to a knowledge-based society. While improvement in internet technologies have been used to build better technical infrastructures for eLearning, the lack of standardisation has hindered the development of the eLearning industry resulting in customer dissatisfaction and delay in widespread adoption of this new paradigm of education and training. A number of standardisation efforts are currently underway and in this paper we shall place some of these standards into context taking a closer look at two areas: application architecture and learning content (including metadata).

1. Introduction

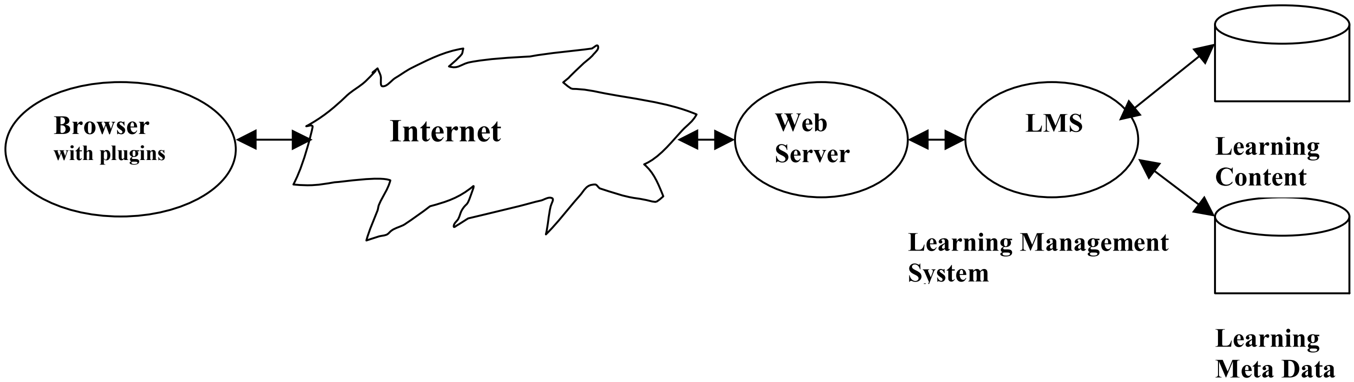
eLearning is the creation, enabling, delivery and/or facilitation of lifelong learning by leveraging various Internet and Web technologies**.** eLearning is an outgrowth of a number of far-reaching societal and technological changes that have been evolving over the last several years. Today's primary training methods are instructor-led training and computer-based training. Leveraging the internet for training now provides the capabilities to break through the barriers of these methods. eLearning enables the delivery of interactive learning to anyone, anywhere, at any time, and across any platform. Most importantly, eLearning requires only a fraction of the resources associated with traditional training methods.

Even though the potential of eLearning has been realised by all, the lack of standards in this area has severely prevented the widespread adoption of this mode of learning. The lack of standards was the result of the legacy of proprietary CBI systems many of which were retrofitted to make them work over the web. However, the internet is a living example of the advantages of standardisation, and it was natural that educational technology that is suppose to use the internet as its backbone should itself be based on standards. Standards are critical for the success of the eLearning industry since they help us answer questions such as:

- How will we mix and match content from multiple sources?
- How do we ensure that we are not trapped by a vendor's proprietary learning technology so as to protect our investments in eLearning?

A large number of organisations are currently involved in various standardisation efforts **[1]**. A few among them are: IMS Global Learning Consortium, Inc.(www.imsproject.org), Aviation Industry CBT Committee (AICC) (www.aicc.org), Institute of Electrical and Electronic Engineers (IEEE) Learning Technology Standards Committee (LTSC) (ltsc.ieee.org), Advanced Distributed Learning (ADL) Initiative (www.adlnet.org), Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE), Dublin Core.

The standardisation activities are taking place with respect to different dimensions of web-based learning and in some cases there are overlaps being addressed by the different groups. In order to place the various standards in context let us take a look at the generalised structure of a web-based learning system:



In this paper we shall **not** concern ourselves with the implementation options, e.g., whether an ORDBMS is used to store the learning content or a CMS (content management system), whether the LMS is implemented using Java Servlets or Active Server Pages, etc. Rather we shall see how the various standards fit into the generalised structure given above. Of the various areas where standardisation efforts are going on we shall focus on two: application architecture of LMS' and learning content.

The rest of the paper is structured as follows. In section 2 we discuss application architecture issues and focus on the IEEE LTSA standard. In section 3 we discuss learning content issues and focus on the ADL SCORM standard. Section 4 concludes the paper with pointers to some further areas which needs to be looked into in the light of standardisation efforts.

2. Application Architecture

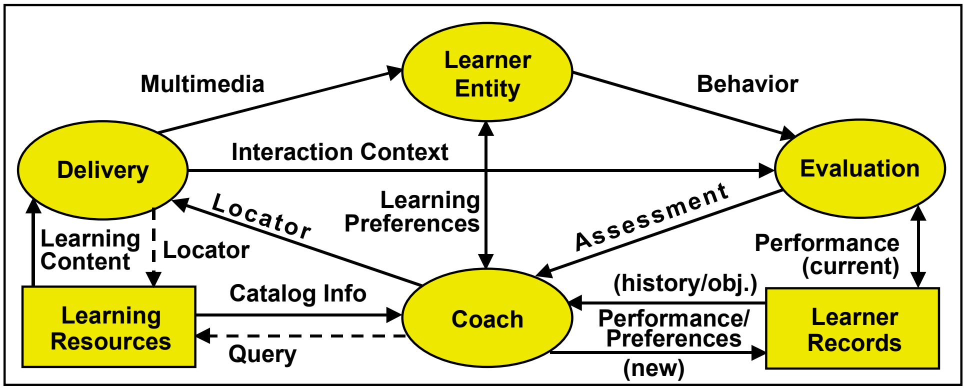
There are a plethora of LMS', each with its own application architecture (even though all are based on the internet as their infrastructure), and each is sold as a monolithic system (rather than as a component based system) in the sense that it is not possible to create an eLearning system by combining components purchased from different LMS vendors. What is needed is a mechanism for defining the application architecture of LMS' in terms of a reference model. The Learning Technology Standards Architecture (LTSA), proposed by the IEEE LTSC, provides such a reference model.

3.1 The LTSA[2]

The LTSA system components are:

- **Processes**: learner entity, evaluation, coach, delivery.
- **Stores**: learner records, learning resources.

- **Flows**: learning preferences, behavior, assessment information, performance and preference information (three times), query, catalog info, locator (twice), learning content, multimedia, interaction context.



The **learner entity** process is an abstraction of a human learner. The learner entity may represent a single learner, a group of learners learning individually, a group of learners learning collaboratively, a group of learners learning in different roles, and so on. The learner entity receives a multimedia presentation and its behavior is observed.

The LTSA **behavior** system component provides "raw" information about the learner's activities, which is recorded in real time and used to evaluate the results of learning. The learner entity's observable behavior is an input to the **evaluation** process. The evaluation process produces assessment information (e.g., "where the learner is at") and sends the assessment information to the coach. The evaluation process creates performance information that is stored in the learner records. The evaluation process uses the interaction context to provide context to the learner entity's behavior to determine the appropriate evaluation. The evaluation process may send or update performance information to the learner records (e.g., "question 17, answered correctly, 85 seconds elapsed").

The **learner records** stores performance information. Perfo rmance information may come from both the evaluation process (e.g., grades on lessons) and the coach (e.g., certifications). The learner records may hold information about the past (e.g., historical learner records), but may also hold information about the present (e.g., current assessments for suspending and resuming sessions) and the future (e.g., pedagogy, learner, or employer objectives).

The **assessment** process may provide information about the learner's current state, which may be used by the coach component to determine optimal learning experiences.

The **coach** is defined in 5 steps. These steps may be performed in any order. Steps may be omitted during the learning experiences.

Step #1: The coach may negotiate the learning preferences (learning styles, strategies, etc.,) with the learner entity.

Steps #2 and #3: The coach component may receive the current assessment information from the evaluation process and performance information from the learner records to support the decision-making process for choosing future learning experiences.

Step #4: Based on the current assessment information and historical performance information, the coach may send **queries** to the learning resources to search for appropriate learning materials. The queries may specify search criteria based on, in part, learning preferences, assessment information, and performance and preference information. The learning resources returns catalog info, i.e., a list of locators that match the search query.

Step #5: The appropriate **locators** (e.g., a lesson plan, pointers to content) are sent to the delivery process.

The **learning resources** component may store representations of knowledge, presentations, tutorials, tutors, tools, experiments, laboratories, and other learning materials as resources for learning experiences. The **catalog information** data flow is the result of searches of the learning resources, as directed by queries. The catalog information is also known as "learning object metadata". Metadata is may be used in web content for facilitating searches. However, web content metadata is inadequate for learning content because learning content requires more search criteria (e.g., pre-requisites, co-requisites, learning style) than what is provided for in web content (e.g., title, subject, author, keywords).

The **learning content** data flow is a coded representation of materials that help create, coach, suggest, deliver, etc., the learning experience(s). The learning content may be identified by the locator, retrieved by the learning resources, and transformed by the **delivery process** into an interactive multimedia learning experience.

The **interaction context** is a data flow from the delivery component to the evaluation component that may provide information (a framework) necessary for interpreting the "raw" information supplied by the behavior data flow. The **multimedia** data flow is the simultaneous delivery of several types of media, such as video, audio, and graphics from the delivery process to the learner entity. The delivery system may transform the learning content into an interactive multimedia presentation to the learner entity.

2.2 Discussion

An architecture isn't a blue print for designing a single system, but a framework for designing a range of systems over time, and for the analysis and comparison of these systems, i.e., *an architecture is used for analysis and communication*. By revealing the shared components of different systems at the right level of generality, an architecture promotes the design and implementation of components and subsystems that are reusable, cost-effective and adaptable, i.e., *critical interoperability interfaces and services are identified*. Even though the LTSA was not developed specifically for web-based learning systems it is sufficiently generic to be used for describing the architecture of LMS'. The LTSA thus provides a model using which:

- The application architecture of current LMS' may be analysed and compared – Doing this exercise would reveal that most LMS' are glorified "HTML page-turners" since they do not have the critical components that are necessary for providing learners with customised learning experiences, e.g., Coach, Learner Models, Learner Preferences, etc.

- New generation LMS' may be built resulting in the growth of a component-based LMS industry that would enable customers to construct an LMS of their choice by combining LMS components from different vendors.

3. Learning Content

In the ideal world, content developed for one LMS should be usable by another LMS. In fact, it should be possible for third party developers to produce content (taking the help of subject matter experts and instructional designers) that should be usable by any web-based learning system. This dream is about to come true due to a number of standardisation efforts in the area of learning content, the most important among them being SCORM (Sharable Content Object Reference Model).

The SCORM is a set of interrelated technical specifications built upon the work of the AICC, IMS and IEEE to create one unified 'content model'. SCORM consists of three main sections:

- an Extensible Markup Language (XML)-based specification for representing course structures (so courses can be moved from one server/LMS to another);
- a set of specifications relating to the run-time environment, including an API, content-to-LMS data model, and a content launch specification; and
- a specification for creating meta-data records for courses, content, and raw media elements.

Of the above three aspects of SCORM we feel that runtime environment standardisation (which is a side-effect of the concept of executable content) is not really conducive to content interoperatbility (this aspect is elaborated in section 3.3) and we shall focus on the purely descriptive aspects of the course structure format and metadata issues.

3.1 The SCORM CSF (Course Structure Format)[3]

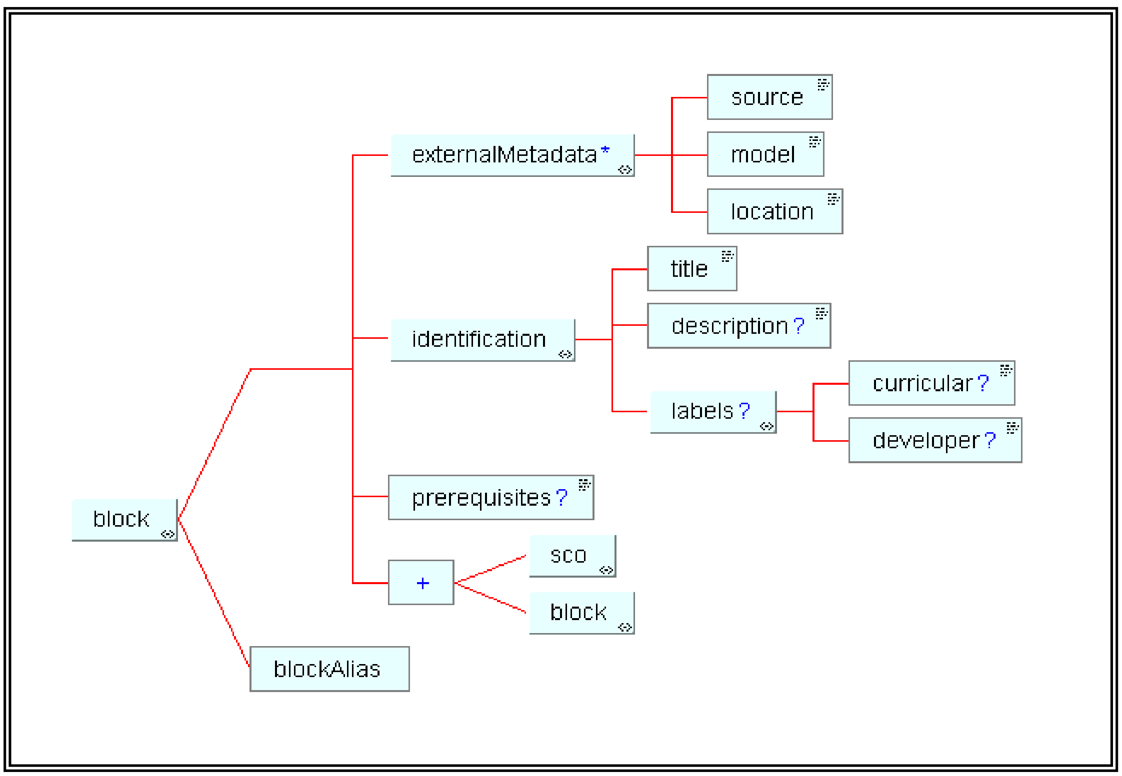
CSF is an XML based representation of a course structure that can be used to define all of the course elements, structure, and external references necessary to move a course from one LMS environment to another. The CSF describes a course using three groups of information. The first group, called *globalProperties*, is the data about the overall course. The second, called *block*, defines the structure of the course, and the third group, *objectives*, defines a separate structure for learning objectives with references to course elements within the assignment structure. The detailed structure of CSF is given below:

<globalProperties> This element contains or references information about the learning content aggregation as a whole (external metadata). It also provides information describing the general approach used during the design of the learning content (cuuricular taxonomy).

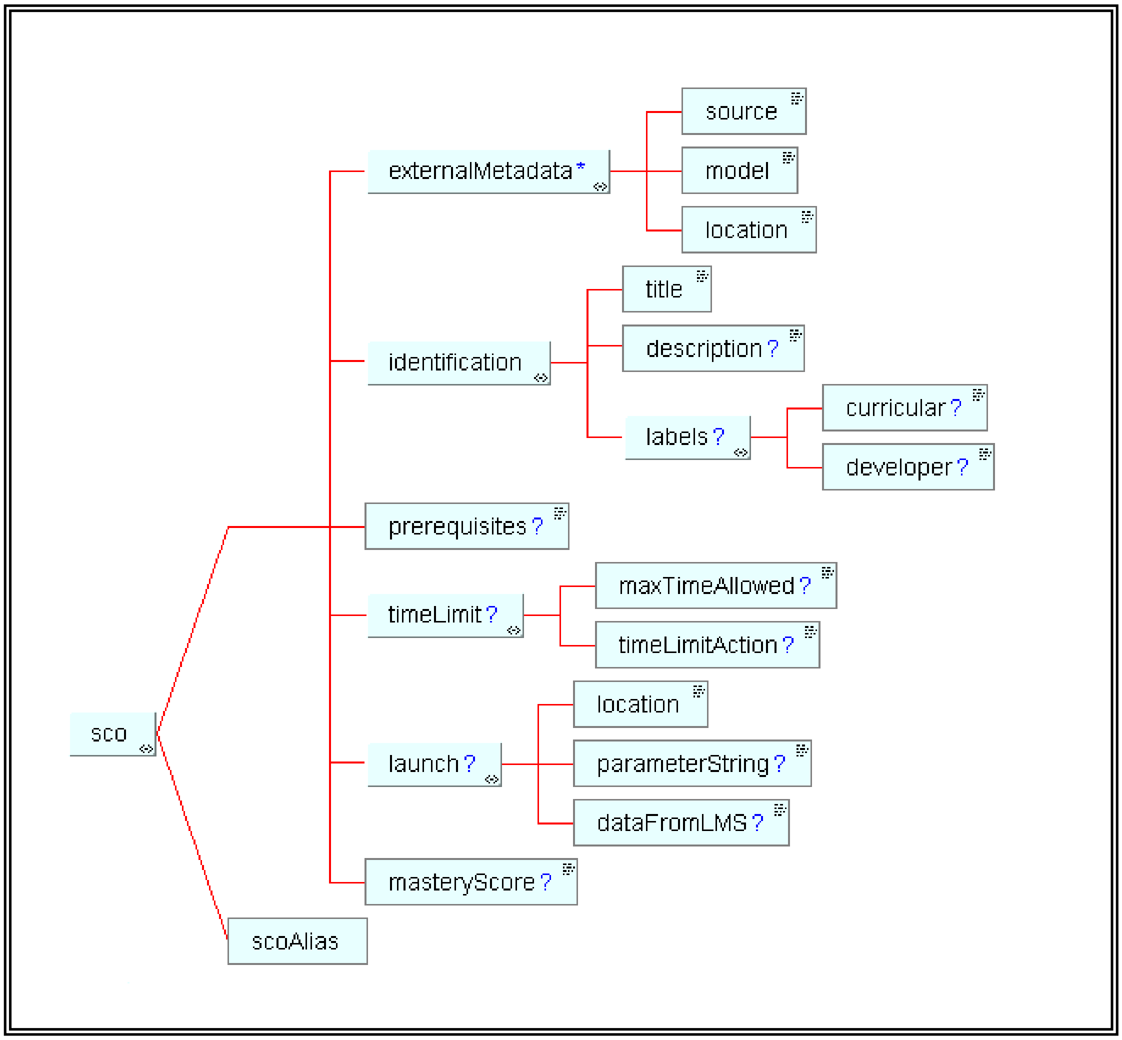
<externalMetadata> This element is used to reference meta-data that describes the learning content as a whole. This meta-data defines, among other things, information that can be searched externally such as the learning content title, description, version, etc.

<curricularTaxonomy> This element sub-structure identifies the methodology of a particular community of users in assembling the learning content components in the CSF. This sub-structure indicates the user community and therefore infers the structure of the learning content, naming conventions (e.g., "unit", "lesson", "learning step", etc.) and number of levels or tiers of content aggregation.

<block> This element defines all of the learning content components and their organizational structure. This is the outermost level that may contain other Blocks and SCOs (Sharable Content Objects)**.** This tree structure defines a hierarchical lesson plan for learning content. The ordering of the tree elements defines a default sequence for the execution of each of the SCOs making up the learning content aggregation. Embedded within this hierarchical tree structure are data elements defining the type, source and location of each learning content component.



<sco> This element represents a Sharable Content Object (SCO). A SCO is the smallest element of learning content to which a student may be routed by a LMS.



<externalMetadata> : This element is used to reference meta-data that describes the SCO. This meta-data defines, among other things, information that can be searched externally such as the SCO title, description, version, etc.

<identification> This element provides context-specific information about the SCO including title, description, curricular label and developer label.

> **<title>** This element contains the context specific title for the Block or SCO. It may be used by an LMS system for menus, screens, etc.
>
> **<description>** This element contains the context specific textual information about the Block or SCO. It may contain the purpose, scope, summary, etc.
>
> **<labels>** This element contains context specific information used to label the Block or SCO. This sub-structure is intended to capture valuable information about learning

content and its construction. However, these elements are considered informative and are not expected to affect how the learning content is actually delivered.

<curricular> This element is intended to be used to describe the name of the Block or SCO according to local practices. This element could be used to identify names representing levels of a taxonomic learning hierarchy such as “Course”, “Unit”, “Lesson”, “Module”, “Learning Step”, etc.

<developer> This element may be used to store a tag or label for the Block or SCO useful to the developer, following a convention within an organization or as a byproduct to the use of a tool. This element allows such information to be contextualized and carried along with learning content when it is moved

<prerequisites> This element defines what other parts of the learning content aggregation must have been completed before starting the SCO. This allows an LMS to compute multiple paths through the learning content.

<timeLimit> This element sub-structure defines time values and actions associated with this SCO in this context.

<**launch**> This element sub-structure contains information needed by an LMS to launch the SCO.

<**location**> This element contains the URI location of the SCO
<**parameterString**> This optional element contains a character string to use during the launch of the SCO if needed.
<**dataFromLMS**> This optional element provides a place for initialization data expected by the SCO after launch. This data is unconstrained and undefined.

<masteryScore> This element establishes the passing score for this SCO. Note that what is considered a passing score often depends on the context of a SCO within the learning content aggregation. Some learning content aggregations may opt to set the mastery score for a SCO higher than in others.

3.2 Metadata

The purpose of meta-data (data about data) is to provide a common nomenclature so that learning content can be self-describing. Learning content that is tagged with self-describing meta-data can be systematically searched for and retrieved for use and reuse. Meta-data for learning content, has been under development within a number of national and international organizations over the past few years: IMS, IEEE LTSC, ARIADNE, all of which were themselves inspired by the generic metadata work done under the Dublin Core initiative. The SCORM effort makes use of the work done by these various groups and provides a standard for eLearning metadata.

The SCORM identifies three types of learning content meta-data: raw media, content and course. There are nine categories of meta-data elements:

- The *General* category groups the general information that describes the resource as a whole.
- The *Lifecycle* category groups the features related to the history and current state of this resource and those who have affected this resource during its evolution.
- The *Meta-metadata* category groups information about the meta-data record itself (rather than the resource that the record describes).
- The *Technical* category groups the technical requirements and characteristics of the resource.
- The *Educational* category groups the educational and pedagogic characteristics of the resource.
- The *Rights* category groups the intellectual property rights and conditions of use for the resource.
- The *Relation* category groups features that define the relationship between this resource and other targeted resources.
- The *Annotation* category provides comments on the educational use of the resource and information on when and by whom the comments were created.
- The *Classification* category describes where this resource falls within a particular classification system.

3.3 Discussion

Executable content is an extreme security hazard and is prohibited by most firewalls – and for good reason. The end-user has no way of knowing what will happen when executable code is launched. Under the SCORM 1.x model, it is entirely possible to sequence SCOs that contain malicious code. It is being widely felt [4] that to promote interoperability and achieve accessibility, content must be purely descriptive, devoid of any executable client-side code (i.e. executable content, calls to plug-ins, JavaScript, java, etc).

The development of small, reusable and interoperable pieces of learning content, and the shift of control flow from embedded within content to an external representation which can be processed by the LMS establishes the basis for entirely new learning technologies. The most obvious benefits of sharability and reuse are the possibility of large content repositories and the development of a new "content economy" where Sharable Content Objects are traded widely. An even more interesting prospect is the development of complex learning management systems that can assemble, reorder and redefine learning content to fit the real-time needs of the learner. Unfortunately, the lack of reusable and re-sequenceable content has delayed this vision from becoming reality. Standardisation efforts such as SCORM are providing a starting point for the next generation of advanced learning technologies that can be highly adaptive to the learner's individual needs.

4. Conclusions

We have seen in the above sections of this paper that a number of efforts are going on in creating elaborate standards for various dimensions of eLearning. It can be seen that some of these standards fit in with each other; for example the SCORM CSF may be used to provide a standard for the Learning Resources component of the LTSA. What appears to be missing from all the standardisation work is the connecting link with the field of ID (instructional design) and other related research areas such as Learning Theory, ITS (intelligent tutoring systems), etc.. If eLearning is to go beyond "HTML page-turners" it is absolutely necessary to relate the various standards with the standards used in the fields of ID, ITS, etc. For example, the Overlay Student Model [5] used in ITS' may be used in conjunction with the Learner Records component of the LTSA.

In this connection we would like to mention some additional areas where we feel the eLearning community needs to initiate some standardisation activities.

- *Security* – Security is going to become increasingly important as the eLearning industry matures and business transactions (B2B or B2C) in the domain of eLearning become commonplace.
- *Intellectual Property Right (IPR)* – This is a very important area in any knowledge based domain and especially so in eLearning where content will be developed by one party, delivered by another party, and used by another party.
- *Vernacular support* – In order for eLearning to be really delivered to the masses, the delivery of learning has to be done in the language of the student. The work done by PROMETEUS (www.prometeus.org) in the area of multicultural, multilingual learning is notable in this regard.

References

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[5] *Overlay student models,* A. Serengul Guven Smith, www.cs.mdx.ac.uk/staffpages/serengul/Overlay.student.models.htm