Enabling Content Sharing in Contemporary Medical Education: A Review of Technical Standards

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ENABLING CONTENT SHARING IN CONTEMPORARY MEDICAL EDUCATION: A REVIEW OF TECHNICAL STANDARDS

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ABSTRACT

This paper attempts a review of existing technical standards that relate to electronic medical education. The review is conducted from a perspective that contemporary medical education is much linked with the collaborative development, the sharing, and the re-purposing of learning material (educational content), which is also the central notion of a Europe-wide best practice network named "mEducator". So the paper defines the so called mEducator educational content space and makes an effort to identify and describe in brief different standards that relate to any of its facets. Emphasis is also placed on the interrelationship between all these standards with regards to the mEducator space, while its importance for online medical education is discussed.

KEYWORDS: medical education, e-learning, digital content, digital library, case/problem based learning, Healthcare LOM, SCORM, standards, competency, intellectual property, profile, packaging quality

INTRODUCTION

Without doubt, Information and Communication Technology (ICT) has been much employed in contemporary medical practice, as well as, education. For the latter, teaching institutions, which are regularly required to revisit and enrich their curricula with highly specialized courses, but also to conform with governmental directives and commission guidelines, often use a variety of web-based Learning (Content) Management Systems (LCMS). Moreover, the recent explosion of Web 2.0 (collaborative, social web) applications offered new opportunities for health education by allowing open access to information, sharing of ideas, questions, and opinions etc. in a social collaboration type of interaction. So, nowadays, ICT may be required to support the development of virtual distributed pools of autonomous specialized educational modules and provide the mechanisms for searching, retrieving, evaluating and rating, adapting and revising educational content in medicine and life sciences. However, current e-learning research indicates that access to such comprehensive repositories of learning objects can only be efficient and useful, if appropriate descriptions of those objects – in the form of metadata – are enabled. In other words, and to utilize a frequent e-health keyword; educational (e-learning) object interoperability may only be reached if different users (e.g. medical teachers), as well as, systems (e.g. LCMS for medical education) are in a position to "understand" the qualities of each educational object. The latter argument binds well with the general notion of "standardization". But before going any deeper, a key definition and an answer to an elementary question need to be clarified:
-what does "sharable training/teaching" refer to?
-why would medical educators require any sharing of (standardized) educational/training content?

"Sharable training/teaching" refers to training/teaching objects (typically digital objects referring to e-learning, but may include other delivery methods), which are shared across multiple organizations[1]. But if organizations "share" such objects, then they are inevitably develop an interest towards the use of metadata (and standards) that describe the content to be shared. In that way, organizations (and their involved peers) are then able to: transfer content into other organizations, modularize/re-use content in other courses, overcome platform problems /allow for multiple delivery options, keep an account of versioning/updating/life-cycle of content, relate content to other situations (re-purpose), share assets, media, etc.

However, to effectively enable the sharing of state-of-the-art digital medical educational content among medical educators and students in European higher academic institutions through a standards-based infrastructure one needs to tackle and elaborate on pedagogical, technical, standardization, cultural, social and legal issues towards. The cultivation of this need was what lead to a newly launched, EU funded Best Practice Network (BNP) called mEducator[*], aiming to implement and critically evaluate existing standards and reference models in the field of e-learning in order to enable specialized state-of-the-art medical educational content to be discovered, retrieved, shared and re-used across European higher academic institutions.

So, the aim of this paper is to provide a critical review (and first evaluation) of existing standards and reference models in the field of e-learning in order to enable the aforementioned retrieval, sharing and re-using of the state-of-the-art medical educational content targeted by the mEducator BPN. To do so, the paper first provides a short description of the different types of content relevant to mEducator, while then attempts to sketch the so termed "mEducator Space", i.e. the broad mEducator approach space where all different medical (e)learning related key terms meet, i.e. student/user profiles, competencies, content packaging, content protection (intellectual property rights), evaluation and quality etc. Numerous standards available for each of the above terms are then explained and their interrelations are retrieved and depicted. The paper concludes with the discussion of the relative importance of the above points for the success of the mEducator project, as well as, contemporary medical education itself.

CONTENT AND STANDARDS NEEDS IN THE "mEducator" SPACE

Contemporary medical education may include numerous types of educational material like conventional educational content types (lecture notes, presentations etc), educational content types unique in medical education (e.g. teaching files, virtual patients etc) and alternative educational content types (problem/case based learning sessions via web 2.0 technologies, serious games (2D/3D), web traces, wikis, blogs/discussion forums, etc).

Among the various definitions available in academia re the "learning objects" or "learning units", in the mEducator project, reference is made to a "*learning content item",* which refers to educational material with a registered history of creation, linked with specific educational goals and objectives, as well as, learning outcomes and educational contexts/settings, and is recommended with certain teaching methods & strategies types, while assessed/evaluated by certain means to accomplish the fulfillment of its predefined learning outcomes. To this effect, a content item may be a lecture in Powerpoint slides or podcast/vodcast of any length, or a Virtual Patient of a various size, as long as it is properly accompanied by a clear description (this will be metadata descriptions) of what objectives it meets, what learning outcomes it envisages, how is it supposed to be taught, and how is it assessed (in other words accompanied by its assessment means).

The above discussion indicates clearly the need to bind the learning material with various (available) standards. Figure 1 attempts a pictorial summary of the relevant areas covered in mEducator where standards might be available. The synthesis of all those areas composes the so-called *standards mEducator space*. That space includes:

-The broader area of procedures for describing content items; it considers both structure and packaging of content items, according to existing (or to be extended) educational packaging

[*] http://www.meducator.net

standards. Current packaging standards will be composed and extended in order to include all content types. For instance, the packaging of web 2.0 artifacts (blogs/wikis/discussion forums and others), or serious games (2D/3D), or web anatomical traces, compose a severe challenge to currently available standards. mEducator content items should be described with metadata that provide information about the content items themselves, such as Title, description, learning objectives, Continuing Medical Education (CME) credits etc. These metadata, namely learning object metadata, facilitate a content item's search and retrieval.

-The broader area of competencies. Metadata that represent characteristics of competence are needed, so as to enhance the interoperability of competence based learning systems within mEducator. Structured competencies that appear as part of a learning or career plan, such as learning pre-requisites, or as learning outcomes will improve the search, retrieval and repurposing of learning objects.

-The learner's profile space. Broadly speaking, the educational context where learning is trialed and tested will include medical schools and training hospitals. So, learner information (or else the profile of learner) attempting the interaction with the learning content items/objects is valuable information for repurposing the latter. To this extent, repurposing of content items includes repurposing for different target users such as Medical Educators, Undergraduate medical students, Postgraduate medical students, Resident doctors, Medical Professionals, Public etc.

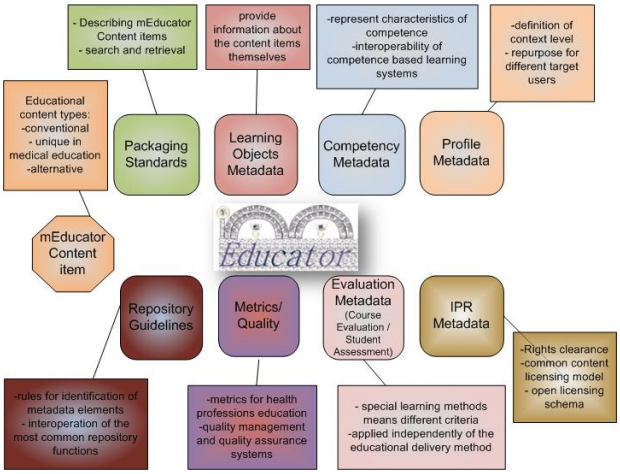

Figure 1. metadata concepts of the mEducator space

-The broader area of Evaluation. Evaluation includes the dual notion of course evaluation, and learner assessment (student assessment, self-evaluation, etc). It is an important module of traditional and online medical education. When teaching and learning methods are special, the means and criteria to evaluate and assess the course programmes cannot remain the same. Online medical learning requires the adoption of new standards that will be applied independently of the educational delivery method. So, evaluation metadata are generally divided into two categories: course evaluation and student assessment (including self-evaluation). These metadata should enable the deployment of item banks across a wide range of learning and assessment delivery systems.

-The area of quality assurance. Quality of LOs and courseware from the pedagogical, technical, design, and accessibility perspectives is an issue at search, retrieval and re-purposing of mEducator content items. Metadata that provide a consistent format and data structure for representing metrics for health professions education are needed. To this extent, description of methods and metrics are required for implementing quality management and quality assurance systems when stakeholders design, develop, or utilize information technology systems used for learning, education, and training.

-Last but not least is the area of Intellectual Property Rights (IPR). Central to mEducator is the issue of IPR resolution for provided content, newly introduced content (during or after the project), as well as, for re-purposed content. The legal issues associated with IPR involve

Copyright, Moral Rights, Confidentiality, Trademarks, Patents and other rights that empower their holders with (exclusive) rights to control reproduction or adaptation of such works for a certain period of time. Educational material such as textbooks may be copyrighted by institutions, and medical videos, images and audio, may have rights appending to the hospitals or clinics in which they were acquired. Rights clearance for this type of material is a key theme of mEducator project and a common content licensing model, or open licensing schema, will need to be adopted to enable their open exchange in a context where educators and learners create and shape knowledge in common. Metadata describing this model or schema should be adopted or extended.

STANDARDS IN ONLINE MEDICAL EDUCATION

As mentioned above, Learning Objects (LOs), as independent units of educational material targeting to specific training needs, constitute one of the main research topics in the e-learning community. Many research initiatives in the field concern the issue of LOs' reusability. The e-learning community colloquially uses the word *standard* to denote one of the following concepts[2]:

- *official standard*: a set of definitions, requirements, formats, and design guidelines for elearning systems or their components that a recognized standards organization has documented and approved.
- *de facto standard*: the same as an official standard, but widely accepted only by the community and industry—that is, lacking formal approval from a recognized standardization body.
- *specification*: a document on the same issues as an official standard, but less evolved; usually developed and promoted by organizations or consortia of partners from academia, industry, and educational institutions. It captures a rough consensus in the e-learning community and is used as a de facto standard in system and content development.
- *reference model*: an adapted and reduced version of a combination of standards and specifications focusing on architectural aspects of an e-learning system, definitions of parts of the system, and their interactions

For every standard, specification, or reference model that exists, a crucial question that can not be easily answered arises: "is this standard, specification, reference model going to be widely adopted and maintained through the years"? Nobody can answer this question with certainty, but characteristics such as the needs covered by a standard, the organization/consortium that proposes it, the time created and many other can perhaps partially clear the scene.

In this paper an effort is made to identify standards that can affect the mEducator space in terms of searching, retrieving and re-purposing a content item. The full picture of the origins and interlinks of all such standards in the mEducator space is illustrated in Figure 2.

Packaging Educational Standards that mEducator may adopt and extend can be: ADL's Sharable Content Object Reference Model (SCORM)[3] and SCORM for Healthcare[4], which has been designed as a set of eXtensible Markup Language (XML) based specifications that can define, manage, access and deliver modular educational objects so that they are easily shared among different e-learning management systems. SCORM was born from various organizations and standards, including the AICC (Aviation Industry CBT Committee)[5] that provides the CMI (Content Management Instruction) Model for content structure which is extended to CSF (Content Structure Format) in order to include new capabilities for Web-based content. CSF is an Extensible Markup Language (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 (Learning Management System) environment to another. The IMS CP (Content Packaging)[6] consists of a part for Metadata and a part for Content Structure organizations. The Metadata Part of the IMS CP includes metadata standards, like Healthcare LOM, IEEE LOM, IMS Metadata, or others. The Content Structure part of IMS CP contains Content Structure Models, like SCORM CFS, AICC CMI, or others.

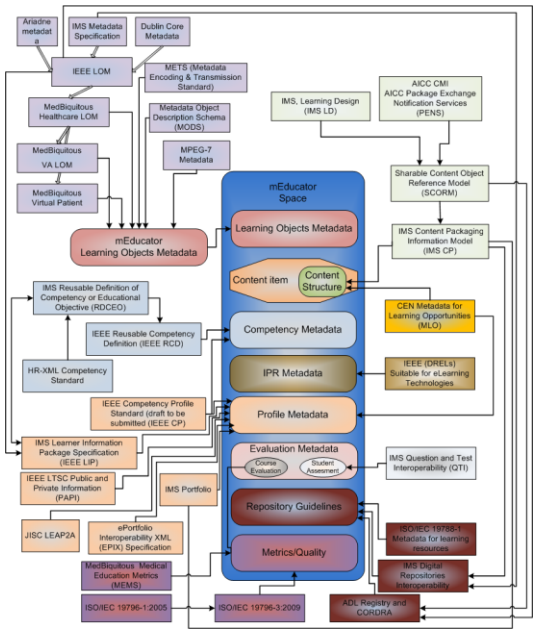

Figure 2. the "starting picture" of the standards mEducator Space

Content items, as independent units of educational material targeting to specific training needs, also constitute one of the main research topics in the e-learning community. Many research initiatives in the field address the issue of reusability, via designing standards (official or de facto), specifications and reference architectures. mEducator Learning Object Metadata, addressing attributes used to describe content items, could be an extension of Healthcare Learning Object Metadata (LOM)[7] in combination with MedBiquitous Virtual Patient[8] and MedBiquitous VA LOM[9]. Healthcare LOM, which was recently issued as an ANSI standard, extends the IEEE LOM standard[10]. It describes in detail the content items or learning objects through ten (10) general categories and it is, of course, XML based. MedBiquitous Virtual Patient is a data standard for the exchange and re-use of virtual patients (one of the content item types in mEducator) and MedBiquitous VA LOM is a draft in an ongoing process to extend Helathcare LOM for Veteran Affairs. Many organizations interfere in the IEEE LOM creation by providing knowledge and attributes of their metadata schemes. Those were Dublin Core Metadata[11], ARIADNE[12] metadata and IMS metadata[13]. The main idea in IEEE LOM's creation was to define the minimum set of attributes capable of describing, managing, locating and evaluating LOs.

As mentioned above, content items in mEducator may contain videos, audios, games, etc. Thus, MPEG-7 Metadata[14], formally named "Multimedia Content Description Interface", which is an ISO/IEC standard developed by MPEG, may also be relevant herein. MPEG-7 describes the multimedia content data that allows the interpretation of the information meaning, which can be passed onto, or accessed by, a device or a computer code.
Regarding the bibliographic taxonomy of a mEducator content item, MODS[15] and METS[16] will be examined. Metadata Object Description Schema (MODS) is a schema for a bibliographic element set that may be used for a variety of purposes, and particularly for library applications, created by the Library of Congress. The Metadata Encoding & Transmission Standard (METS) schema is a standard for encoding descriptive, administrative, and structural metadata regarding objects within a digital library, expressed using the XML schema language of the World Wide Web Consortium. The standard is maintained in the Network Development and MARC Standards Office of the Library of Congress, and is being developed as an initiative of the Digital Library Federation.
In order to justify competency metadata in the mEducator space, the IMS RDCEO, IEEE RCD[19] and HR-XML[20] Competency Standards will be examined. The IMS Global Learning Consortium released in October 2002 a specification for Reusable Definition of Competency

or Educational Objective (RDCEO)[17,18] which contains an information model, a best practices document and an XML binding. This Specification provides unique references to descriptions of competencies or objectives for inclusion in other information models. The IEEE RCD[19] standard provides a formal way of representing the key characteristics of a competence, independently of the context. The purpose of the standard is to enhance the interoperability of competence based learning systems by offering them a model of standardized competence definitions with standardized semantics. It is based on the existing IMS RDCEO[17,18]. HR-XML[20] is a world-wide standard for the formalization and ranking of competences, supported by HR-XML Consortium. A standard format is used to exchange data about human resource (including competences).

Profile Metadata in mEducator can be derived from the combination of many standards. The IEEE Competency Profile Standard (draft to be submitted (IEEE CP))[21] defines an information model for describing, referencing and exchanging data about the relationships between competences in a competence profile. IMS Portfolio[22] is defined as a collection of portfolio parts that are collated in an IMS Content Package[6]. Another interesting approach regarding ePortofolio Metadata is the JISC LEAP2A[23] which stems from the JISC CETIS - (JISC Innovation Support Centre - Centre for Educational Technology & Interoperability Standards) project called Portfolio InterOperability Project. It represents e-portfolio information collected by the individual (learner) and not the information stored by the others (teachers) about this individual. LEAP2A is based on Atom Syndication Format. The IMS Learner Information Package (LIP)[24] Specification, which was released in 2001, is a collection of information about a Learner (individual or group learners) or a Producer of a learning content (creators, providers or vendors). The IMS Learner Information Package (IMS LIP) specification addresses the interoperability of internet-based Learner Information systems with other systems that support the Internet learning environment. IEEE LTSC Public and Private Information (PAPI)[25], support the exchange of learner data between different systems. It describes a particular subset of all possible types of learner information. Learner information is considered a subset of general information about learning technology. Last but not least, the ePortfolio Interoperability XML (EPIX) Specification[26] was created to support a standard protocol for the integration of disparate applications, to support the integration of ePortfolio applications with other enterprise and personal systems, as well as, to manage transportability of ePortfolios and the items contained within the ePortfolio across computing devices.

Evaluation mEducator metadata consist of Metadata regarding student assessment and course evaluation. For information regarding student assessments, the IMS Question and Test Interoperability (QTI) v2.0 Final Specification[27] describes a data model for the representation of question (assessmentItem) and test (assessment) data and their corresponding results reports. It is related to content providers, developers of authoring and content management tools, assessment delivery systems and learning systems. The data model for representing question-based content is suitable for targeting users in learning, education and training across all age ranges and national contexts. Course evaluation can be in relation with metrics and quality standards in order to reassure the content accuracy, quality and delivery.

There are two approaches regarding quality and metrics that should be taken into consideration in the mEducator Space. The ISO/IEC 19796-1:2005 "Information technology -- Learning, education and training -- Quality management, assurance and metrics -- Part 1: General approach"[28] describes, compares, analyses, and implements quality management and quality assurance approaches. It will serve to compare different existing approaches and to harmonize these towards a common quality model. An extension of ISO/IEC 19796-1:2005, the ISO/IEC 19796-3:2009 "Information technology -- Learning, education and training -- Quality management, assurance and metrics -- Part 3: Reference methods and metrics"[29] provides a harmonized description of the methods and metrics required to implement quality management and quality assurance systems for stakeholders designing, developing, or utilizing information technology systems used for learning, education, and training. The second approach comes from MedBiquitous with MedBiquitous Medical Education Metrics (MEMS)[30]. It is a reference model that provides a consistent format and data structure for

representing metrics for health professions education. It enables the exchange of education metrics between disparate systems and organizations over the Web.
In mEducator, effort will also be spent on defining all content-related IPR issues, and describing them as IPR Metadata. The IEEE Trial-Use Recommended Practice for Digital Rights Expression Languages (DRELs) Suitable for eLearning Technologies[31] facilitates the creation, management and delivery of digital content for eLearning by technology that implements Digital Rights Expression Languages (DRELs). This recommended practice determines what, if any, extensions are needed so that these DRELs can meet the identified requirements. It should also be taken under consideration for extending the recommended practice by IEEE to the dominant licensing scheme, worldwide nowadays, for non-software material, the Creative Commons (CC)[32], allowing the creative re-use of intellectual works, whether owned or in the public domain. The Creative Commons are based on the distinction of the rights of a copyright holder, covering the whole spectrum of possibilities between full copyright (all rights reserved) and the public domain (no rights reserved) as applied by copyright laws in different countries.
Furthermore, CEN Metadata for Learning Opportunities (MLO)[33] is a European standardized model for addressing metadata of learning opportunities. The standard defines the electronic representation of learning opportunities in order to facilitate their advertising and subsequent discovery by prospective learners. It will contribute, by becoming a bridge, both to Content Packaging and to ePortofolio metadata.
Last but not least, repository guidelines will take into consideration three existing standardization efforts. "ISO/IEC 19788-1 Metadata for learning resources — Part 1: Framework"[34] and "ISO/IEC 19788-2, ITLET - Metadata for Learning Resources - Part 2: Core Elements"[35] specify, in a rule-based manner, metadata elements and their attributes for the description of learning resources. This includes the rules governing the identification of metadata elements and the specification of metadata attributes, while part 2 eases the work of implementers and editors of the subsequent Parts by providing common properties, such as Title, Description and others. IMS Digital Repositories Interoperability - Core Functions Information Model[36] provides recommendations for the interoperation of the most common repository functions. These recommendations should be implementable across services to enable them to present a common interface. This specification is intended to utilize schemas already defined elsewhere (e.g., IMS Meta-Data and Content Packaging), rather than attempt to introduce any new schema. The last and the newest effort comes from ADL with "The ADL Registry and CORDRA"[37]. It is the first publicly available CORDRA implementation. The ADL Registry provides a mechanism to search for digital objects and enables their discovery and reuse.

DISCUSSION

In the past, we have outlined our intention to start thinking about the initiation of the use of e-learning standards by the health informatics academia[38]. It is almost certain that collaboration and content sharing in health education will inevitably alter the overall process of developing and preparing course materials[39]. The formation of task forces and content sharing networks/consortia, like mEducator, will ensure that responsibility is not merely vested in just one of the institutions involved. To this extent, the purpose of this paper was quite clear, as it was nothing else but outlining the plurality and diversity of available e-learning standards and their relevance in the mEducator best practice network space. As the paper shows and its figures illustrate, there is a lot of work already carried out by numerous societies and organizations. However, the remaining challenge of all these, as well as, for any individual standard of course, is their wide adoption and ease of use. It is obvious that if a model is well designed and described and a tool for using it is provided, then it should be a simple matter to incorporate human computer interaction principles to make its use friendly enough for its endeavored wide adoption. However, mEducator by origin touches upon some issues (e.g. Web2.0 content etc) that is not clearly described/covered by any of the standards available. Therefore, it is imperative that the mEducator consortium will work closely with

standardization organizations so as to propose standards extensions. It is hoped that all this will take over the next three years or so, for the benefit of contemporary medical education.

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