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

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ABSTRACT

This paper reviews existing technical standards related to electronic medical education. It is conducted from the perspective that contemporary medical education is greatly linked with collaborative development, sharing, and re-purposing of learning material (educational content). This is the central notion of a European-wide best practice network named "mEducator". The paper defines the mEducator educational content space and attempts to identify and describe different standards that relate to its various facets. Emphasis is also placed on the interrelationship between all these standards with regards to the mEducator space and its importance for online medical education.

INTRODUCTION

Information and Communication Technology (ICT) are increasingly being employed in medical practice, as well as in education. For the latter, teaching institutions, which are regularly required to revisit and enrich their curricula with highly specialised courses, and also to conform with governmental directives and commission guidelines, often use a variety of web-based Learning (Content) Management Systems (LCMS). This has been facilitated by web development and web design that supports interactive information sharing, interoperability, user-centred design and collaboration on the World Wide Web (W3). This new functionality is often referred to as Web 2.0, although fundamentally nothing has changed about the W3. Today, ICT may be required to support the development of virtual distributed pools of autonomous specialised educational modules and provide the mechanisms for searching, retrieving, evaluating and rating, adapting and revising educational content in medicine and life sciences.

Current e-learning research indicates that access to such comprehensive repositories of learning objects can only be efficient and useful, if appropriate descriptions

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of those objects – in the form of metadata – are enabled. In other words, 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. This is in keeping with the general notion of "standardisation".

"Sharable training/teaching" refers to training/teaching objects (typically digital objects in e-learning, but can encompass other assets), which are shared across multiple organisations[1]. However if organisations "share" such objects, then they inevitably develop an interest towards the use of metadata (and standards) that describe the content to be shared. In this way, organisations (and their involved peers) are then able to:

- Transfer content into other organisations
- Modularise/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.

To effectively enable the sharing of state-of-the-art digital medical educational content through a standards-based infrastructure, it is necessary to tackle and elaborate on pedagogical, technical, standardisation, cultural, social and legal issues. To address this requirement the European Union (EU) have funded mEducator Best Practice network (BPN) a project focused on Multi-type Content Repurposing and Sharing in Medical Education. Its aim is the implementation and critical evaluation of existing standards and reference models to enable specialised state-of-the-art medical educational content to be discovered, retrieved, shared and re-used for e-learning.

The purpose of this paper is to provide a critical review and evaluation of existing standards and reference models in the field of e-learning for enabling retrieval, sharing and re-using of state-of-the-art medical educational content required by mEducator BPN.

CONTENT AND STANDARDS NEEDS IN THE "MEDUCATOR" SPACE

Contemporary medical education may include numerous types of educational material such as 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 (2Dimensional/3Ddimensional), web traces, wikis, blogs/discussion forums, etc).

Among the various definitions available in academia with respect to "learning objects" or "learning units", in the mEducator project, reference is made to a "*learning content item*". This 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. It is recommended for certain teaching methods and strategy types, which can be 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. Each content item must be 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 it is assessed.

The above requirements indicate the need to bind the learning material with various (available) standards. Figure 1 visually summarises the relevant areas covered in mEducator where standards might be available. The synthesis of all those areas comprises the so-called *standards mEducator space*. This space includes:

- **Procedures for describing content items**. Both structure and packaging of content items must be considered according to existing (or to be extended) educational packaging standards. Current packaging standards will have to 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, constitute a severe

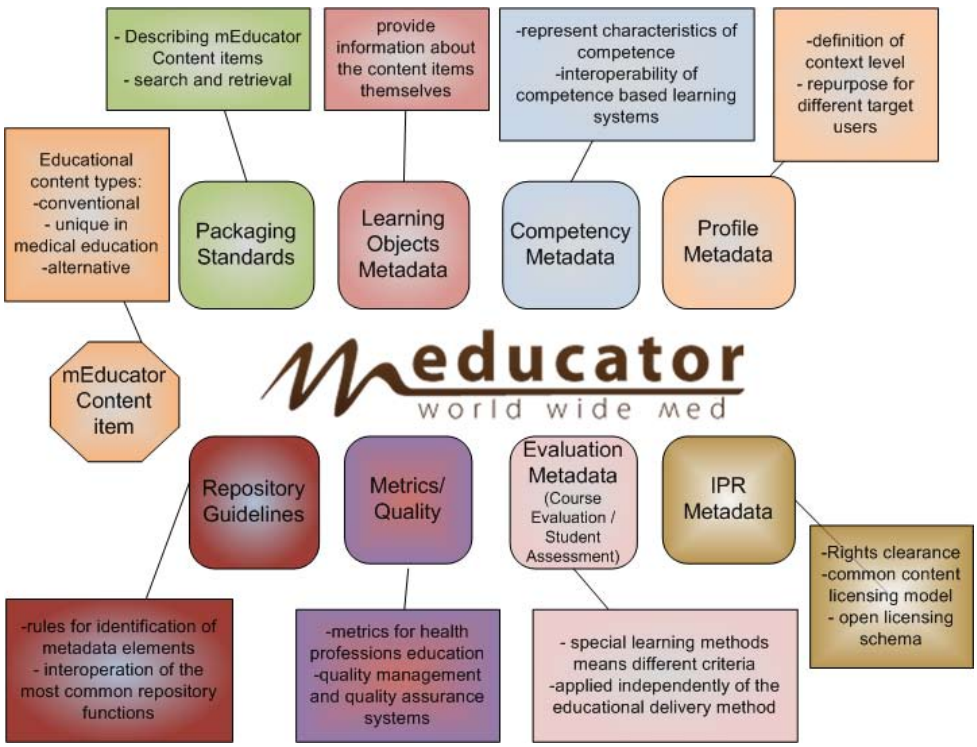

Figure 1. *Metadata concepts of the mEducator space*

challenge to currently available standards. mEducator content items should be described with metadata that provides 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.

- **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 teaching hospitals. Consequently information about the learner, or the profile of the 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, medical students, junior doctors, medical professionals, the public, etc.
- **Evaluation**. Evaluation includes the dual notion of course evaluation and learner assessment (student assessment, self-evaluation, etc). It is an important feature of traditional and online medical education. When teaching and learning methods are specialised, the means and criteria to evaluate and assess 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. Consequently 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.
- **Quality assurance.** The quality of learning objects (LOs) and courseware from the pedagogical, technical, design, and accessibility perspectives is an issue for search, retrieval and re-purposing of mEducator content items. Metadata that provide a consistent format and data structure for representing metrics for health professionals' 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 utilise information technology systems used for learning, education, and training.
- **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 the 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 needs to be adopted or extended.

STANDARDS IN ONLINE MEDICAL EDUCATION

As mentioned above, Learning Objects (LOs), as independent units of educational material targeted 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 reusability of LOs. 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 recognised standards organisation 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 recognised standardisation body.
- *Specification*: a document on the same issues as an official standard, but less evolved; usually developed and promoted by organisations 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 arises: "Is this standard, specification, reference model going to be widely adopted and maintained through the years"? This question cannot be answered with certainty, but characteristics such as the needs covered by a standard, the organisation/consortium that proposed it, when it was created and other factors may be helpful.

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 origins and interlinks of such standards in the mEducator space is illustrated in Figure 2.

Packaging Educational Standards that mEducator may adopt and extend can be: ADL's (Advanced Distributed Learning) 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 organisations 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

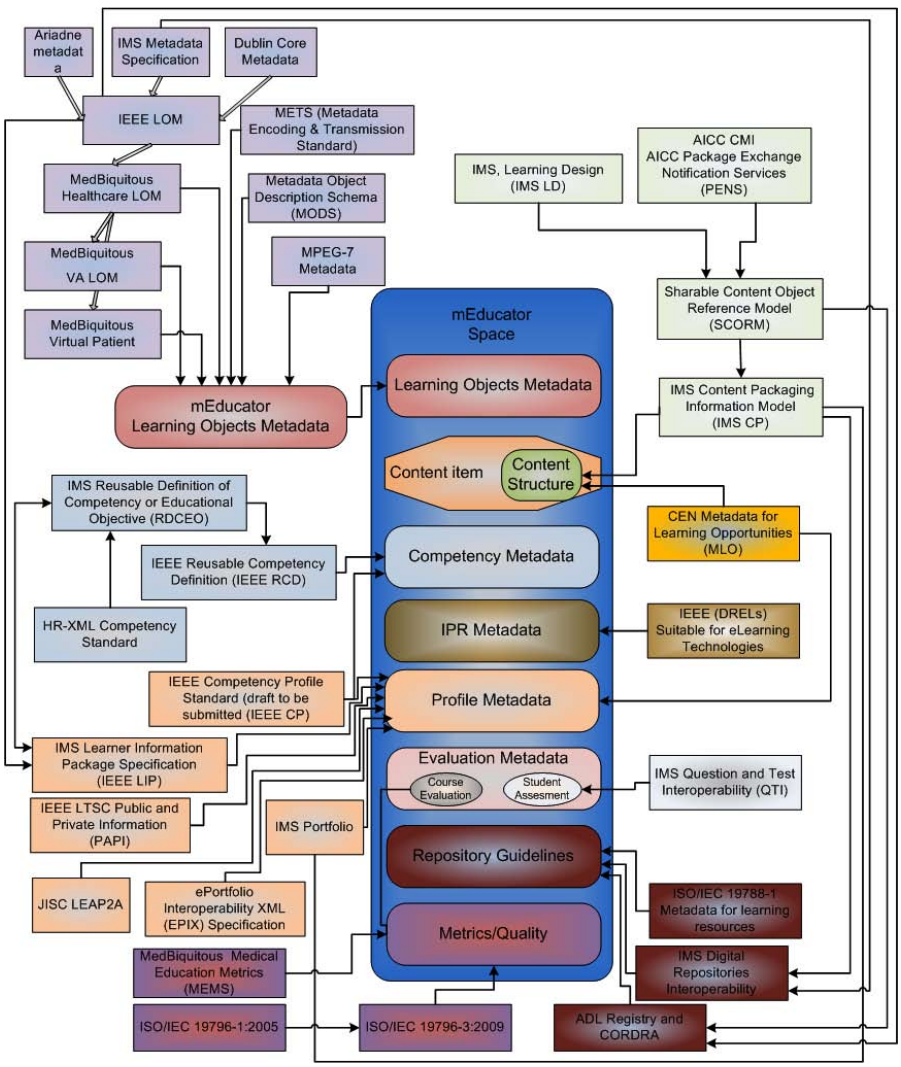

Figure 2. *The origin of the standards mEducator Space*

the course elements, structure, and external references necessary to move a course from one LMS (Learning Management System) environment to another. The IMS CP (Internet Protocol Multimedia System Content Packaging)[6] consists of a part for Metadata and a part for Content Structure organisations. The Metadata Part of the IMS CP includes metadata standards, like Healthcare LOM (Learning Object Metadata), IEEE (Institute of Electrical and Electronics Engineers) LOM, IMS Metadata, or others. The Content Structure part of IMS CP contains Content Structure Models, like AICC CMI, and others.

Content items, as independent units of educational material targeted 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 (American National Standards Institute) standard, extends the IEEE LOM standard[10]. It describes in detail the content items or learning objects through ten general categories and is 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 Veteran affairs LOM is a draft in an ongoing process to extend Healthcare LOM for the Veteran Affairs organisation. Many organisations contributed to the IEEE LOM creation by providing knowledge and attributes of their metadata schemes. These 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 video, audio, games, etc. Thus, MPEG-7 Metadata[14], formally named "Multimedia Content Description Interface", which is an ISO/IEC (International Standards Organisation/ International Electrotechnical Committee) 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.

With respect to the bibliographic taxonomy of a mEducator content item, Metadata Object Description Schema [15] and Metadata Encoding and Transmission Standard[16] will be examined. Metadata Object Description Schema 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 and Transmission Standard 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 (Machine Readable Cata-

loging) Standards Office of the Library of Congress, and is being developed as an initiative of the Digital Library Federation.

In order to justify competency of metadata in the mEducator space, the following competency standards will be considered:

- IMS Definition of Competency or Educational Objective (RDCEO)
- IEEE Reusable Competency Definitions (RCD)[19]
- Human Resources – Extensible Markup Language (HR-XML)[20]

The Reusable Definition of Competency or Educational Objective specification was released by the IMS Global Learning Consortium in October 2002[17,18]. This specification provides unique references for descriptions of competencies or objectives for inclusion in other information models. It contains an information model describing core aspects of the specification including details of semantics, structure, data types, value spaces, multiplicity, and obligation (i.e. whether mandatory or optional). This is accompanied by an XML binding description, i.e. how the information model is bound to XML version 1.0. A Best Practices and Implementation Guide provides non-normative guidance on application of the Information Model and XML Binding.

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 standardised competence definitions with standardised semantics. It is based on the existing IMS RDCEO[17,18].

HR-XML[20] is a world-wide standard for the formalisation and ranking of competences, supported by the 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[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 (Joint Information Systems Committee) LEAP (London Eprints Access project) 2A[23] which stems from another project – the Portfolio InterOperability Project. It represents e-portfolio information collected by the individual (learner) and not the information stored by others (teachers) about this individual. LEAP2A is based on the 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 (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 of mEducator metadata consists 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 a question (assessment Item) 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: General approach"[28] describes, compares, analyses, and implements quality management and quality assurance approaches. It will serve to compare different existing approaches and to harmonise 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: Reference methods and metrics"[29] provides a harmonised description of the methods and metrics required to implement quality management and quality assurance systems for stakeholders designing, developing, or utilising 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 professionals' education. It enables the exchange of education metrics between disparate systems and organisations 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 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.

CEN Metadata for Learning Opportunities (MLO)[33] is a European standardised 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.

Finally repository guidelines must take into consideration three existing standardisation efforts. "ISO/IEC 19788-1 Metadata for learning resources: Framework"[34] and "ISO/IEC 19788-2, ITLET – Metadata for Learning Resources: Core Elements"[35]. These 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. The Core Elements eases the work of implementers and editors of the subsequent Parts by providing common properties, such as Title and Description. 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 utilise 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 Advanced Distributed learning (ADL) with "The ADL Registry and CORDRA" (Content Object Repository Discovery and Registration/Resolution Architecture)[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

We have previously expressed the need to focus on the initiation of the use of e-learning standards in 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 or a few involved institutions. To this extent, the purpose of this paper was quite clear – to outline the plurality and diversity of available e-learning standards and their relevance in the mEducator best practice network space. As the paper has demonstrated, a lot of work has already been carried out by numerous societies and organisations. However, the remaining challenge

for these, as well as for individual standards 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 it user friendly enough for its endeavored wide adoption. However, mEducator by origin touches upon some issues (e.g. Web2.0 content) that is not clearly described/covered by any of the standards available. Therefore, it is imperative that the mEducator consortium works closely with standardisation organisations so as to propose standards extensions. It is hoped that all this will take place in the near future for the benefit of contemporary medical education.

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