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1 Project Objectives

Medical educational content is available in individual EU academic institutions, although not widely available or easily discoverable and retrievable, due to lack of standardized content sharing mechanisms. Institutions, to support their teaching, often use a variety of web-based Learning (Content) Management Systems (LCMS), as well as, educational standards which are developed and adopted to enable the universal description of educational content through the web.

Web2.0, or else the social web, a term coined in some 6 years ago, has highlighted the importance of openness, social collaboration and participation, social networking and crowd intelligence. Web 2.0 applications have offered new opportunities for health education as well, since they allow open access to information, sharing of ideas, questions, and opinions etc. “Mashup” technologies have recently been used to implement efficient brokerage mechanisms for educational content sharing.

Moreover, semantic service-oriented approaches previously developed in EC funded projects, have provided the underlying, commonplace technology (semantic web services) towards federating educational repositories or LCMSs together. Recent advances in the semantic web front, have shed light and emphasis on the notion of linked data, which basically concerns the publishing of structured data so that it can be interlinked more effectively and hopefully become more useful.

A lot of effort has also been put in the area of educational content development, description, and sharing, however there was no prominent clear and standards-based solution for the seamless sharing of educational content in medicine and in general.

To this extent, the aim of mEducator was to elaborate on pedagogical, technical, standardization, cultural, social and legal issues and develop a standard-based infrastructure to enable the sharing of state-of-the-art digital medical educational content among medical educators and students in higher academic institutions. As a Best Practice Network, mEducator has developed and compared two alternative and contemporary ways (solutions/frameworks) of achieving content sharing, namely:

1st Solution: mEducator 2.0, based on Web2.0 technologies and mashups in specific

2nd Solution: mEducator 3.0, based on semantic web technologies and linked data in specific.

mEducator has managed to achieve the following objectives that contribute directly to the overall and specific objectives of the eContentplus programme and Action 4.1:

- provided mechanisms for content publishing, discovery, & retrieval
- analysed policies and mechanisms for content evaluation, rating, renewal and repurposing
- elaborated on intellectual property rights for educational material
- tested the impact of true interoperability, repurposing, enrichment, and embedding of a variety of highly attractive and up-to-date learning resources
- provided recommendations on how to implement interoperable educational content discovery and retrieval networks
- Implemented and extended specifications and standards on a critical mass of medical educational content types and provided recommendations for standards adoption and promotion across Europe.
- Supported the efficient and seamless sharing and use of formal, specialized, state-of-the-art and pedagogically sound medical educational content across Europe.
- Compared best practice solutions referring to both user generated and professional generated content
- Experimented with the impact on technology enhanced user interaction and community learning (Web2.0).
- Built upon previously funded research and experience while involving new member states and quite good geographic coverage and aimed impact.
2 Consortium

mEducator consortium consisted of 14 partners, representatives of 9 EU member countries, which acted in close collaboration towards the objectives of the project. Some partners, mainly Medical Schools, acted as content providers of educational content for medical education, while others as technology providers who provided state-of-the-art technological solutions or expertise for sharing and repurposing of multi-type content in medical education. Moreover, some other partners acted as pedagogic experts and/or users and played a major role in the project evaluation of the sharing solutions and the specification of recommendations.

Participants & their role in the project

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<tr>
<td>GR</td>
<td>Aristotle University of Thessaloniki (AUTH)</td>
<td>Coordinator, Technology &amp; Content provider, User/Evaluator, Disseminator</td>
</tr>
<tr>
<td>CY</td>
<td>University of Cyprus (UCY)</td>
<td>Technology &amp; Content provider, User/Evaluator, Disseminator</td>
</tr>
<tr>
<td>GR</td>
<td>Democritus University of Thrace (DUTH)</td>
<td>Content provider, Technology provider, User/Evaluation, Disseminator</td>
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<tr>
<td>IR</td>
<td>MEDTING Medical Exchange Limited (ex. SITUSI Limited)</td>
<td>Content provider, Technology provider, Disseminator</td>
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<tr>
<td>RO</td>
<td>Technical University of Cluj-Napoca (UTCN)</td>
<td>Technology provider, Disseminator</td>
</tr>
<tr>
<td>FR</td>
<td>Université Nice Sophia Antipolis (UNS)</td>
<td>Content provider, Pedagogical expert, User, Disseminator</td>
</tr>
<tr>
<td>BG</td>
<td>Medical University Plovdiv (MUPLOVDIV)</td>
<td>Pedagogical expert, Content provider, User, Disseminator</td>
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<tr>
<td>IT</td>
<td>Università degli studi di Catania (UNICT)</td>
<td>Pedagogical expert, Content &amp; Technology Provider, User/Evaluator, Disseminator</td>
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<td>FI</td>
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<td>UK</td>
<td>St George’s, University of London (SGUL)</td>
<td>Medical Education (pedagogical) expert, Standardisation Body Liaison, Technology and Content Provider, Disseminator</td>
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The mEducator consortium has been supported and assisted regularly by Associate Partners. A sample of these appear on the project web site:

http://www.meducator.net/?q=associate-partners
3 Project Results/Achievements

Project results are categorised in four main pillars, namely, Platforms/Frameworks, metadata, repurposing, and finally recommendations and best practices. The following few sections provide details for each.

3.1 Platforms/Frameworks

3.1.1 Content sharing solution 1: mEducator2.0

mEducator 2.0 is the first mEducator Content Sharing Solution, which aims at creating a brokerage mechanism based on mashups and other technologies, which allows medical educational content to be shared across websites, or, in our case, individual partners’ LCMSs, by creating a loosely coupled network of LCMSs.

mEducator 2.0 allows for exchanging of content via “mash-up” technology and Web 2.0 tools for loosely coupled isolated LCMSs.

The mEducator consortium has finalized the development, evaluation and customization of the brokerage mechanism based on “mashup” and the user interface in HTML/CSS. The database is being used as a central repository to store learning objects metadata, user information, etc and is being made accessible remotely through Mashup technologies from individual LCMSs.

Target users such as residents & specialized Doctors, medical educators and medical students are able to see mEducator educational material through the mEducator2.0 portal and access it through their own systems using mashup technologies.

mEducator partners acting as content providers implemented the mashup of mEducator 2.0 in their own LCMSs. Pilot content testings have been performed to allow the implementation of the relevant functionalities for repurposing, in both platform and mashups.

mEducator users across multiple institutions may utilise the mashups for uploading, creating, and editing content metadata, as well as for the search and retrieval of content. Alternatively, for users without access to a specific LCMS, an independent platform has been created which applies web 2.0 techniques and facilitates user collaboration, allows the creation of social networks for medical education, knowledge exchange and second opinion.

The mEducator2.0 platform is accessible at: www.meducator2.net

The term Web 2.0 is associated with web applications that facilitate collaboration on the World Wide Web, including social networking sites, blogs, wikis, video sharing sites, hosted services, web applications, mashups and folksonomies.
3.1.2 Content sharing solution 2: mEducator3.0

mEducator 3.0 allows for exchanging of content via Semantic Web Services technologies for federated LCMSs.

The consortium has finalized the development, evaluation and customization of the Semantic Web Services brokerage, exposing educational services and LCMS in a Linked Data-oriented way ("Linked Services") to enable the automated discovery/execution of distributed services. Tools and services (API's) have also been developed in order to allow the integration of federated LCMSs.

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3 The term Web 3.0 is associated with the Semantic Web
Two different approaches have been tested in mEducator.

1st approach:

The Linked Services environment allows distributed queries across distributed and heterogeneous LCMS (services/APIs) on the fly while query results are lifted into RDF automatically. All educational metadata as retrieved in the services integration step are stored in a dedicated RDF store containing the mEducator – Linked Educational Resources dataset⁴. Metadata is enriched based on Linked Open Data (LOD) datasets, taking advantage of available APIs such as the ones provided by BioPortal⁵, which allows access to a vast number of established taxonomies and vocabularies represented in a LOD compliant way.

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⁴ http://ckan.net/package/meducator
⁵ http://www.bioontology.org/wiki/index.php/BioPortal_REST_services, a web site which has a large list of Biology ontologies
**2nd Approach:**
The second approach allows better for multiple instances: each organization is able to independently deploy and control its own instantiation of mEducator. In other words, keep the data on the instantiation and federate search and discovery. The search federation is lying with the ability to search in a collection of datasets using a single endpoint and obtain uniform results. The central issue here is that each platform implements the searching functionality differently, while the solution is provided through SPARQL 1.1 which allows for an efficient federation and optimised implementation.

### 3.1.2.1 mEducator 3.0 instantiations

Different platforms have been created to achieving semantic interlinking of repositories based on mEducator3.0. These are: MELINA+, MILES+, LinkedLabyrinth+, Metamorphosis+. All mEducator 3.0 instantiations expose metadata from educational repositories by the use of APIs being queried on the fly, returning resources described in the “mEducator schema” (see below).

![A generic diagram of metadata utilisation in mEducator3.0](image)

**Target users such as residents & specialized Doctors, medical educators and medical students access mEducator educational material through multiple instantiations using the same technology.**

The mEducator3.0 technology and instantiations are accessible at: [www.meducator3.net](http://www.meducator3.net)
**MELINA+: Medical Education LINked Arena**

MELINA+ is one of the implementations of the mEducator3.0 technologies. It is a content management system for medical educational resources, based on Drupal 7, an open source content management system. MELINA+ has been developed to allow resources to be created, uploaded, described, shared and searched over the semantic web in different ways. It exploits SPARQL queries using the Drupal SPARQL endpoint functionality. Multiple endpoints (including internal and external) could be added in SPARQL registry and queried. It supports the creation and description of learning resources, user registration/authentication, advanced search capabilities, a commenting/rating/bookmarking system, and blogs and posts.

Its advanced features include: core RDF support, embedded SPARQL endpoint, DBpedia spotlight annotation, social learning collaboration, quality process control for learning resources, single sign on via WEBID module. MELINA+ is an open source Drupal instantiation profile, freely downloadable through the mEducator website.

Visit through:
http://www.meducator3.net/melinaplus/

Watch the YouTube video at:
http://youtu.be/LyB_numQnHQ

**MILES+: Medical Inter-Linked Educational Space**

MILES+ is a Learning Content Management System based moodle 2.0 in which core changes were conducted in terms of the description of resources, the rating of resources, the messaging (including User Collaboration) and finally the user profile. It has been developed to allow current installations of moodle to be updated into MILES+ so that resources may be created, uploaded, described, shared and searched over the semantic web in different ways. It exploits SPARQL queries using a D2R server with the associated RDF responses complying with the mEducator RDF schema. The D2R server is a tool for publishing relational databases on the Semantic Web. It enables RDF and HTML browsers to navigate the content of the database, and allows applications to query the database using the SPARQL query language.
MILES+ has imported into moodle the following blocks: FOAF profile and the Geotagging of Educational Resources. The additional moodle repositories it exploits are the mEducator Sesame Store and mEducator 3.0 instantiations. In addition, MILES+ may enrich one’s resources with accompanied resources from Clinical Trials and Pubmed, while it enables the User Collaboration, as well as the “Educemiology” of Medical Education Resources (see below).

MILES+ is freely downloadable through the mEducator website as a moodle2.0 module.

Visit through:
http://www.meducator3.net/milesplus/

Watch the YouTube video at:
http://youtu.be/njMpFBR7fes

Metamorphosis+:

The Metamorphosis+ environment, developed in the early phase of the project as a testbed for the metadata description scheme and content sharing mechanisms, was used as one possible user interface to the general architecture of mEducator 3.0, showcasing the suitability of the Linked Services/Linked Data-based approach. It was created based on the ELGG open source social networking platform and consists a complete social environment supporting user management, resource management, users collaboration (creation of groups, blogs, forum), sharing and rating of resources.

The ELGG platform was modified to provide functionalities for describing resources in mEducator metadata format, enriching the resources through connections to different ontologies based on the BioPortal API, describing repurposing activities and visualising repurposing connections between resources. Three main types of searches were implemented in Metamorphosis, these are, semantic search over enriched resources, semantic distributed search, exploratory search based on semantic links between the resources.
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Visit through:  
http://www.meducator3.net/metamorphosisplus/  
Watch the YouTube video at:  
http://youtu.be/9UZ5mLpSwAc

Linked Labyrinth+

Linked Labyrinth+ (LL+) is an open source “online activity modelling system that allows users to build interactive ‘game-informed’ educational activities such as virtual patients, simulations, games, mazes and algorithms”. It is based on OpenLabyrinth (OL) and it has been developed to allow specific resources (virtual patients - VPs, OSCE) to be described, shared and semantically searched. It exploits SPARQL queries using a D2R server with the associated RDF responses complying with mEducator’s RDF schema. In addition to OL, LL+ provides a mEducator Metadata Entry Form, advanced searching and rating of resources, searching VPs & Educational Resources in other LCMSs and other repositories, a mEducator Metadata Export Mechanism (beyond the MVP ANSI standard compliance). It also supports the repurposing perspective.

So, this mEducator3.0 instantiation (LinkedLabyrinth+) supports one of the main mEducator educational resource types, that is Virtual Patients. The latter is by definition the most contemporary problem (or scenario) based learning approach in medical education (PBL). There exist a plethora of material already in that platform (as well as in other interlinked with it platforms) which are entirely PBL. In essence, LinkedLabyrinth+ has been mainly developed to cover for that gap, i.e. provide one of the first PBL platforms over the semantic web.
3.1.3 Testing
Both solutions/frameworks (and all platforms) were tested as for their performance, i.e. the speed of processing requests, which can be determined by measurements like throughput and latency. They were also tested as for usability and interface related aspects, as well as for the quality of the results, i.e. the relevance of the information. Moreover, developments were made by technical partners for the provision of a redundant architectures aiming at system sustainability.

3.2 Metadata

3.2.1 The mEducator metadata description schema for educational resources

One of the main achievements of the mEducator project is the creation of the mEducator metadata description scheme or else reference model. Initially the consortium proceeded by setting the ground of the conceptual model. This process included the analysis of Healthcare LOM, the evaluation of other specifications and standards, the elaboration on the repurposing notion along with the respective incorporation of extensions for repurposed content, the refinement of educational aspects and the inclusion of companionship of resources. At a later stage, the consortium have considered the benefits of Linked Data and the Semantic Web which allow reusing and linking to existing knowledge making in this way resources interoperable with other data sets. In order to have a metadata scheme compliant with the principles of Linked Data, the Resource Description Framework (RDF) was identified as the most appropriate framework to be used for the treatment of the metadata model. The Conceptual Model was transformed into an RDF Model which in turn was serialized in XML, in order to be processed by machines. Attention metadata have also considerably taken into account and the AAIR mapping (Atom Activity Streams in RDF Vocabulary) has been extended for full tracking of the user activity. The outcome of this work is a metadata description that fits and addresses the requirements and needs for sharing mEducator educational resources which has been submitted and proposed as a Standard to the Medbiqutious Standardisation Body (www.medbiqutious.com).

The conceptual model is presented below:
A graphical illustration of the mEducator conceptual framework

The scheme is available through:
http://www.meducator.net/?q=content/version-august-2011

Moreover, best practice guidelines for the scheme are available at:
http://www.meducator.net/?q=content/best-practises-guidelines

3.2.2 A standalone mEducator schema metadata Editor.

In order to facilitate the process of creating metadata within mEducator the consortium has decided to develop a metadata editor. Metadata editors are tools that enable the creation of xml files in a user-friendly way; otherwise the creation of xml files would be a time-consuming process almost impossible to be processed by non-technical target audience. The first step was to create a Healthcare LOM editor which is currently being customized to the mEducator metadata scheme to serve as the mEducator editor.

The editor is available at:
http://www.meducator.net/?q=content/healthcare-lom-editor-%E2%80%93-meducator-editor

3.2.3 A mEducator cloud in the LOD cloud

A vital role for the Open Data promotion in Universities (and therefore education per se) will be played by the CKAN platform. CKAN is already used for open scientific data. Work performed in mEducator has managed to define a ckan instance for the mEducator open data:
http://ckan.net/package/meducator
This contained more than 35000 triples and more than 1000 links to DBpedia & Bioportal ontologies. The LOD cloud version of September 2011 includes a mEducator cloud as illustrated below.
3.2.4 A mapping tool for following one’s educational resources: educemiology

Like “epidemiology” which concerns “the study of the distribution and patterns of health-events, health-characteristics and their causes or influences in well-defined populations” (Wikipedia, 2012), “Educemiology” is a newly introduced term, which concerns the creation and study of “epidemiological” maps, displaying how medical learning resources from one Institution or academic teacher or expert are distributed to other places and connected to other resources and people, so as to be used in other educational contexts. (http://www.mei2012.org/content/educemiology-%E2%80%9Cepidemiology%E2%80%9D-medical-learning-resources).
3.3 Repurposing

Repurposing refers to the changing of a learning resource initially created for a specific educational context, to a new educational context (or contexts), and should be distinguished from reuse, which refers to the use of the same learning resources without any changes.

The mEducator consortium has researched into various possible types of content repurposing and has established a set of content repurposing contexts and their definitions.

- Repurposing to different languages
- Repurposing to different cultures
- Repurposing for different pedagogical approaches
- Repurposing for different educational levels
- Repurposing for different disciplines or professions
- Repurposing to different content types
- Repurposing for different technology
- Repurposing for people with different abilities
- Repurposing to Educational Content
- Changes in the content itself

The procedure for repurposing medical educational content in general can be complex and may vary greatly from one repurposing case to another. However, a list of major best practices for content repurposing, as elicited by the mEducator consortium, could be proved valuable.

3.3.1 A framework for repurposing serious games

One of the mEducator goals was to attempt to put different types of educational material under a common framework in terms of sharing and repurposing. Some of the mEducator content items involve educational resources in the form of serious medical games. A key project challenge was the way to handle serious games. These have lately attracted much attention and enthusiasm. However, they contain an inherent difficulty, that is, how can the scientific community share and distribute them or exchange experiences of their use in the educational process.

One of the activities of mEducator was the work on the repurposing of serious games. The work conducted involved development work for generating specific scenario wrappers aiming to produce reusable content via content wrappers, scenario editors and web-based tools.

Games’ scenarios are usually hard to repurpose because one needs to edit the source code, provided he has access to it. For those interested in doing so, the following few things are needed:

- a "game" engine;
- artworks (backgrounds, characters, user interface, items), of course compatible with the chosen game engine. For this purpose, some "generic" (preliminary) artwork for a clinical skills lab have been created in mEducator; these may be reused for the purpose of one’s own needs.
- a (medical education) scenario. The latter may be graphically repurposed from an already existing one that facilitates medical history taking and a routine primary health care examination.

The scenario and its components may further be described by a metadata scheme that mEducator has created for describing educational material/resources. Then educators and learners may utilise the dedicated mEducator content sharing platforms (as described in the previous section above) so as to describe and share their games.

3.3.2 A scenario Editor for repurposing serious game scenarios (mEditor)

mEducator serious games providers have developed a tool which was named mEditor, allowing access to the repurposeable parts of a serious game. With this tool, the scenario becomes an XML file, and by proposing a visual representation of the scenario in the form of a graph (node and links), authors are able to navigate through it. This tool is technology agnostic, i.e. it can be bound to any technology, be it a game engine, or any other kind of application.
The main benefits in using the mEditor tool are the following:

- Serious Games are becoming content which can be repurposed
- Games can be played in another engine that share the same features
- There has been a significant decrease in serious games production time (testing phase)

Visit through:
https://test.succubus.fr/ScenarioEditor/
and
https://test.succubus.fr/Livraisons/mEducator/20111219_mEducatorDemo.rar

Watch the YouTube video at:
http://youtu.be/edah1QeDdXo

3.3.3 Serious Semantic Games capitalising upon Linked Open Data (LOD)

Taking the notion of Linked Data and the richness of semantically annotated knowledge in DBPedia, the mEducator consortium has developed one of the first semantic serious medical games. The game begins with a central concept (a drug), that needs to be 'guessed' by the player. The player expands the concept and reveals some of the hints related with it, like for example, other concepts (like a disease targeted by the drug), or a simple property of the original concept (like a brand name). The related concepts can be expanded and a knowledge network is developed through this process. The player has to exchange currency in the most effective manner, to reveal the hints. A correct guess is rewarded.

Watch the YouTube video at:
http://youtu.be/uRperPgsI78

3.4 Recommendations & Best Practices

Best practice is dynamic in nature - what will be best practice now may be, in time, superseded by: innovations in practice, changes in technology, changes in law or governance structures, and expectations, values, knowledge or other influences that make methods outmoded or less relevant, useful or appropriate. For these reasons, best practice must be subject to constant review.
As for the definition of best practice, it has been encapsulated into practice feasible to implement, completed in a usable or user friendly environment, improving the high-level outcomes of users, improving effectiveness in sharing of content, may be continuously improved and can be adapted to fit mEducator institutions and adoptable by other organisations.

In mEducator, the elicited recommendations concern system/platform access, content description (metadata), IPRs, repurposing, and institutional adoptability. A full set of these are provided through the following link:

http://www.meducator.net/?q=content/best-practice-recommendations

3.4.1 A WebID certification framework for mEducator

To allow users for a single user access authentication process (login once in one system, access all systems), m Educator has practiced OpenID. However, the consortium has also developed a WebID module. WebID Authentication is a truly Linked Data oriented module that enables a user to log in a Drupal 7.x site using a client certificate (per the WebID specification). This module depends on the ARC2 library and a fork of libAuthentication (by Melvin Carvalho). To fully control the authentication process, one will also need the WebIDauth service. Users could create their m Educator WebID at http://webid.meducator.net/ods/ and then they can use it in the m educator3.0 MELINA+ instantiation at http://www.meducator3.net/melinaplus

Watch a short YouTube tutorial video for WebID Authentication in meducator3.0 MELINA+ instantiation at:

http://www.youtube.com/watch?v=JIZIPD7ClmE

3.4.2 Recommendations for intellectual property rights (IPRs) for medical educational material

A very important challenge addressed in the first year of m Educator was the issue of Intellectual Property Rights (IPR). All partners have been informed of the legal aspects of intellectual property and issues on Copyright legislation as well as the acts of creators protected. The outcome was a resolution regarding the necessity of a license for all content items to become available through m Educator. The consortium recommended the use of the Creative Commons licensing scheme, although any other license will be accepted. The above recommendations and decisions were established following consultation by experts highly involved and acknowledged in the IP sector.

The adoption of the Creative Commons licensing model in m Educator advocates an initiative aimed at deeper impact on learning. It builds on Open Educational Resources (OER), to create a global culture of learning, which is targeted at preparing people for thriving in a rapidly evolving, knowledge-based world.

The Creative Commons licensing model:

- overcomes the rigidity of the “All Rights Reserved” status and introduces the “Some Rights Reserved” status which is ideal for the design and implementation of projects such as m Educator.
- includes terms and clauses for open distribution of content
- is easy to use by an author or right-holder to grant permissions for any use of their works
- has no cost
- is enhanced by technological elements, i.e. meta-data software code
- is applicable to all sorts of creative works i.e. for all possible types of educational material to be made available through m Educator.

The m Educator project is evolving into a “medical and health sciences gateway.” And it is understood as an opportunity for synergy and mutual benefit between the national and international medical and health sciences communities and the international OER movement, particularly in the sense of evolving into a decentralized learning environment.

The consortium has developed guidelines, designed in the form of workflows, in an interactive platform (Open Labyrinth) to assist partners and stakeholders researching on IPR issues related to the content they would provide. The workflows are publicly available at:
http://labyrinth.sgul.ac.uk/openlabyrinth/mnode.asp?id=qwnw2gqcxdn3lpvju3lpvqajxhgf (for existing provided content)

http://labyrinth.sgul.ac.uk/openlabyrinth/mnode.asp?id=qwnw2gcf4jesnqajxhqqajxhqqdknam (for repurposed content)

For reaching best practice Recommendations with respect to IPR the mEdcuator consortium clustered and collaborated closely with other similar efforts (e.g. PORSCHE in UK). Final recommendations may be codified as follows:

- Adoption of the Creative Commons (CC) policy
- Adhering to the requirements of each CC license type and obey its rules (i.e. enforce a non-commercial use of the resources if the non-commercial license type was indicated)
- Better explanation on the meaning of the IPR abbreviation and options
- Provision of a technical a mechanism to check the validity of the IPR
- Prevent users from linking/repurposing any resources with unclear IPRs
- Defined a policy on how to deal with contents from external repositories for which the IPR clearance is unknown
- Provide clear disclaimers. In order to safeguard mEducator against litigation for copyright or data protection (consent) violation one needs to:
  - Have a policy/disclaimer
  - Clearly publish policy and keep it up to date
  - Train staff in the use of the policy
  - Follow the policy (do what has been said it would be done)
  - Some good practice disclaimers are the following: ‘this resource has been provided… use it at your own risk. If you have any concerns about material in this resource…’ or ‘that ‘this material has been produced to the highest possible ethical standards and anyone with any concerns should contact xxx in writing after which the offending material will be removed within 10 working days pending investigation’.
- Actively manage risks (see risk toolkit in www.medev.ac.uk/ourwork/oer/)
- Take out liability insurance
- Consent everything—even where ownership and patient/non-patient rights appear clear, and store consent with resource
Update with the general rules and guidelines of the General Medical Council (or other similar bodies in EU countries). For example, ‘making and using visual and audio recordings of patients 2001’ referred to clinical care and research, but did not refer to teaching, while ‘making and using visual and audio recordings of patients 2011’ does refer to teaching.

The move towards sharing digital educational resources, for example in the UK, has accelerated institutional understanding of copyright and ethical issues (such as a need for consent for people appearing) in teaching materials. Whole programmes including curriculum documentation and specific learning resources are now routinely being shared under license. To this extent, the following points are relevant:

- Organize workshops/training in copyright, IPR, consent
- Slot in a bit of digital professionalism (literacy)
- Work with professional and statutory bodies to strengthen their guidance
- Create tools to help navigate the legal landscape
- Provide easy access to good practice

Finally, we would like to conform with a recent proposal on consent commons by the PROSCHE group, in order to work alongside or with creative commons as a way of demonstrating due diligence in dealing with issues of consent and using patient data sensitively in learning and teaching with specific reference to being able to share (see for example www.jiscdigitalmedia.ac.uk/clinical-recordings). Consent Commons ameliorates uncertainty about the status of educational resources depicting people, and protects institutions from legal risk by developing robust and sophisticated policies and promoting best practice in managing information. See http://www.meducator.net/?q=content/best-practice-recommendations for further details.

### Recommendations towards true interoperability, repurposing, enrichment, and embedding of a variety of highly attractive and up-to-date learning resources in each of the partners’ curricula

The following composes a set of key findings as far as recommendations are concerned.

- Harmonization of content sharing solution interfaces should be pursued: design solutions do affect overall user acceptance
- Some problems require non technical solutions, such as training on notions of IPR and repurposing.
- Use of Controlled vocabularies is a best practice, provided that they are manageable in size, can be visually scanned rapidly inspectionable/apprehensible
- Best ways to handle notions of quality of the content are still unclear (stamps, formal reviews, inference from other measures) but the need for quality control is strongly felt
- The advantages of adopting semantic web standards for modeling content and services deserve the effort

See http://www.meducator.net/?q=content/best-practice-recommendations for full details.

### Target Users & their Needs

The target user audience of mEducator includes 3 main types of users:

- a. Medical educators (clinical/non clinical, in academia)
- b. Medical Students (under- and post-graduates)
- c. Residents & Specialized Doctors (continuing medical education).

Their needs are illustrated in the figure below:
**Target Users**

- Academics (medical educators)
- medical students (under- and post-graduates)
- medical professionals (residents & specialized doctors)

- better awareness of the uses of Learning Content Management Systems
- efficient search and discovery of educational content
- technical and intellectual property rights related issues involved in sharing contents
- ease of use of educational standards
- access to high quality, well described overspecialized, interoperable and applied to different cultures & languages educational content in state-of-the-art topics
- guidelines on how to easily repurpose educational material and access to and use of toolkits & guidelines to create, edit & share and re-purpose educational content
- access to and (transparent/seamless) use of metadata translation tools
- access to demonstrators and easy use of collaboration environments to collaboratively participate in authoring different scenarios of training, repurposing, standardising and uploading material

Users among the above target groups have been engaged for the evaluation of the developed platforms, as well as for the enrichment of the content to be shared. The following table attempts to provide a summarised overview of the user testing contexts.

<table>
<thead>
<tr>
<th>Evaluation Place, Country, Date,</th>
<th>Group size</th>
<th>Type/Context of users</th>
<th>Nationality of Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna, Austria, 31st August 2011</td>
<td>20</td>
<td>Medical Education Professionals participating in the AMEE conference</td>
<td>From all over the world (English, Dutch, Italian, Finish, Swedish, Indian, American, Brazilian, Mexican, South African, Canadian)</td>
</tr>
<tr>
<td>Plovdiv, Bulgaria, 6th October 2011</td>
<td>25</td>
<td>Medical Professionals, and Medical students (undergraduate)</td>
<td>Bulgarian</td>
</tr>
<tr>
<td>Plovdiv, Bulgaria, 22nd October 2011</td>
<td>15</td>
<td>Students of Dentistry &amp; Medicine</td>
<td>Bulgarian</td>
</tr>
<tr>
<td>Bucharest, Romania, 21st October 2011</td>
<td>15</td>
<td>Medical students (undergraduate)</td>
<td>Romanian</td>
</tr>
<tr>
<td>Bucharest, Romania, 21st October 2011</td>
<td>5</td>
<td>Medical Professionals</td>
<td>Romanian</td>
</tr>
<tr>
<td>Bucharest, Romania, 21st October 2011</td>
<td>15</td>
<td>General Practitioners</td>
<td>Romanian</td>
</tr>
<tr>
<td>Nicosia, Cyprus, Nov. 11 2011</td>
<td>35</td>
<td>Postgraduate students on an e-health MSc course</td>
<td>Cypriot</td>
</tr>
<tr>
<td>Thessaloniki, Greece, 1.12.2011</td>
<td>130</td>
<td>undergraduate medical students attending the Medical Education module</td>
<td>Greek, African, Syrian and Palestine</td>
</tr>
<tr>
<td>Thessaloniki, Greece, 7.12.2011</td>
<td>10</td>
<td>post-graduate medical students &amp; health professionals attending the MSc module on Digital Media in Medical Education and Practice</td>
<td>Greek</td>
</tr>
<tr>
<td>Various Places from 2.12 – 16.12. 2011</td>
<td>18</td>
<td>postgraduate medical, academic medical staff &amp; health professionals (through partners ECCA, SGUL and MUPlovdiv, AUTH)</td>
<td>English, Belgian, Greek &amp; Bulgarian</td>
</tr>
<tr>
<td>Alexandroupolis, Greece, 19.12.2011</td>
<td>31</td>
<td>Undergraduate medical students attending the Molecular Biology programme</td>
<td>Greek</td>
</tr>
<tr>
<td>Thessaloniki, Greece, 12.1.2012</td>
<td>130</td>
<td>(in self-learning mode) undergraduate medical students attending the Medical Education module</td>
<td>Greek, African, Syrian and Palestine</td>
</tr>
<tr>
<td>Vilnius, 1.2.2012</td>
<td>10</td>
<td>Health Professionals</td>
<td>Lithuanian</td>
</tr>
<tr>
<td>Thessaloniki, 4-5.4.2012</td>
<td>50</td>
<td>Medical and Dental Academic Staff, Health Professionals, Post-graduate Students attending the mEducator Spring School</td>
<td>All over EU</td>
</tr>
<tr>
<td>Thessaloniki, May 2012</td>
<td>160</td>
<td>Under-graduate Dental Students attending the module of Dental Informatics</td>
<td>Greek and African</td>
</tr>
</tbody>
</table>
In parallel, the consortium has been seeking to inform the stakeholders outside the consortium about technical achievements (e.g. technical providers of educational (health care) solutions) and make the appropriate contacts with standardisation bodies (e.g. MedBiquitous).

Moreover, the communities of practice that benefit from the outcomes of the mEducator project include the following:

- Drupal CMS community
- Moodle LCMS community
- Medical Education/Virtual Patients/OpenLabyrinth community
- Open source software community
- Semantic web community
- Social Media communities

Finally, let us list other changes and benefits brought up by the mEducator project. For example, individual partner institutions benefit by:

- Modernising their LCMSs
- Updating their educational resources (through sharing)
- Obtaining access to contemporary, state-of-the-art resources
- Attracting student’s attention/collaboration
- Changing their curricula…
- Engaging in internal processes by aligning current strategic plans with mEducator developments
- Getting refreshed with new, young, technical personnel and shaking old minds …

4.1 Multi-lingual and multi-cultural aspects the project has addressed

4.1.1 Multi-lingual aspects

From the user contexts Table above, it is obvious that user testing has taken place with different nationalities (languages) of users. Special care has been taken during the project to allow the design of the mEducator resource description in different languages through suitable mEducator schema attribution. The utilisation of SKOS (SIMPLE KNOWLEDGE ORGANIZATIONS SYSTEM) to describe the taxonomies specified in mEducator, forms also a potential asset of the mEducator approach towards multi-linguality.

In addition to that, however, special care has been taken in mEducator2.0, so that full multi-linguality is supported in all menus and metadata. Automatic translation tools like Bing from Microsoft have also
been employed to provide free translation services for online automatic translation of text and web pages, translating between many different languages. However, a different approach might also be needed, as these tools are not too effective when semantics play a crucial role, as it might be the case in Medical Education. A semantic translation approach might therefore be needed.

To this extent, mEducator has been clustering with the MORMED EC funded project (Multi-lingual & Organic Information Management in the Medical Domain; http://www.mormed.eu/project), which aims to establish and offer a multilingual thematic community platform for rare diseases as a service to groups of interested users. The MORMED team has participated in the mEducator Spring School (see below; also visit http://www.mei2012.org/content/facilitating-sharing-multilingual-content-example-mormed-%E2%80%93demo-and-hands) and a first set of ideas for combining the mEducator and MORMED works has already been initiated.

4.1.2 Multi-cultural aspects

The different nationalities involved in the development of the mEducator platforms as well as the plethora of nationalities involved in testing them provide the first witnessing towards the treatment of multi-culture.

What is more, is the repurposing work carried out in mEducator. In specific, one of the repurposing contexts (see section 3.3 of this report) which also forms part of the mEducator schema, is indeed the field “Repurposing to different cultures”. To this extent, mEducator partners have been engaged in different experimentations. For instance, in the early phases of the project, a repurposing experiment was carried out between partners from UK, Italy, Finland and Greece with respect to repurposing anatomical web traces and including them in Virtual Patient scenarios and vice versa. In another one, ECG traces aiming to teach cardiology related aspects to undergraduate medical students were embedded in a moodle environment and from there repurposed to different educational resources in partner mashed-up LOMSs. One such experimentation was also held in a dedicated session during the mEducator Spring School (see below; also visit: http://www.mei2012.org/content/how-use-patient-data-opportunities-and-challenges-ecg-flash-case). All the above cover different inherent multi-cultural aspects like those of “inter-professionalism”, the use of different “units of measurement” (e.g. between UK and other western Europe), and finally transformations between “lab reference values”.

Moreover, the aforementioned game repurposing scenario editor (mEditor) is well capable of addressing multi-cultural aspects, since it is well suited for procedures involved in “medical history taking” skills which much depend upon the various cultures, the National healthcare laws, and Ethnic groups.

A final point in this list concerns pedagogy itself. Some of the mEducator work has indeed driven a shift of practices in some Institutions. For example, Medical Schools (like that of the Aristotle University of Thessaloniki in Greece) which have largely followed traditional teaching methods (like lectures in an amphitheatre and the exploitation of the corresponding lecture notes/slides) have now engaged a more Problem Based Learning and/or Active Learning approach with Virtual Patients and Game based activities. This is signalling a significant inter-cultural exchange between UK and Greece for example (see for example registered witnessing of a medical academician in the mEducator promotional video: http://www.youtube.com/watch?v=HK5psY48kaQ (time: 00:01:51).

5 Underlying Content

The mEducator consortium has defined content items as the educational material with a registered history of creation, linked with specific educational goals and objectives, as well as, learning outcomes and educational contexts/settings, which are recommended with certain teaching methods and strategies types, while assessed/evaluated by certain means to accomplish the fulfilment of their predefined learning outcomes.

In order to derive best practices for medical educational content repurposing and sharing mEducator partners have identified around 3.000 content items of various types:

- conventional educational content types that are also used in other educational areas, such as lecture notes, books, lecture presentations, exam questions, practicals, scientific papers, graphs, images/videos, algorithms and simulators;
- educational content types unique in medical education, such as teaching files, virtual patients, evidence based medicine forms, objective structured clinical examinations, clinical guidelines, anatomical atlases, electronic traces of images, etc;
- alternative educational content types, either reflecting active learning techniques (extensively used in medical education) and/or stemming from newly introduced web 2.0 technologies, such as problem/case based learning sessions, serious games (2D/3D), web traces, wikis, blogs/discussion forums, etc., including the notion of medical expert instruction in which ever form this may be presented; and
- user generated content, closely related to the above category of active content types, referring to the collection of user interactions with an active learning content item, which by themselves can be later used as an educational item of its own, for example to highlight common mistakes and misconceptions/misconducts, good and bad habits, behaviour trends, etc.

mEducator has analysed a mixture of different resource types

Content providers have described their content items in all mEducator platforms using the metadata scheme. Content items (resources) are available for sharing and repurposing through the two mEducator content sharing frameworks and the various instantiations.

The following two figures provide a summarised snapshot of the content existing in the various mEducator platforms, and the different media types existing in one of them as an example, respectively.

<table>
<thead>
<tr>
<th>mEducator Platforms</th>
<th>mEducator Content</th>
<th>total items</th>
<th>repurposed items</th>
<th>rated</th>
<th>reviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>mEducator 2.0</td>
<td></td>
<td>703</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MELINA+</td>
<td></td>
<td>648</td>
<td>209</td>
<td>188</td>
<td>53</td>
</tr>
<tr>
<td>MetaMorphosis+</td>
<td></td>
<td>420</td>
<td>83</td>
<td>N/A</td>
<td>-</td>
</tr>
<tr>
<td>Linked Labyrinth +</td>
<td></td>
<td>261</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spring School</td>
<td></td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MEI2012 Conference</td>
<td></td>
<td>65</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>federated LCMSs</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>-</td>
</tr>
<tr>
<td>Melina+ Tube</td>
<td></td>
<td>18031</td>
<td>0</td>
<td>97</td>
<td>0</td>
</tr>
<tr>
<td>Miles+</td>
<td></td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

A snapshot of content available in the various mEducator platforms
6  Summary of Evaluation Activities & Methodology

Evaluation work in mEducator has been performed in different distinctive phases as the following few diagrams illustrate:

mEducator partners initiated the evaluation of the 2 sharing solutions early enough in the project cycle in order to detect problems and deficiencies. The methodology used was based on a comparison between the initial functional requirements identified, the use cases that were created and the observation/testing of the solution. The outcomes of technical evaluation have provided useful feedback to the developers for further enhancement of the two sharing frameworks and the different instantiations/platforms.
A detailed account of the evaluation methodology followed in mEducator
7 Dissemination, Impact & Sustainability

7.1 International Dissemination Events

The project goals and objectives, as well as the main technical considerations, were presented in a number of International dissemination events organised throughout the project. However, the following is a list of mEducator sponsored events in the last three years.

- The “1st International Workshop on Multi-type Content Repurposing and Sharing in Medical Education” was organised and held in Larnaca, Cyprus, as part of the International Technology & Applications in Biomedicine conference on 4-7 of November 2009. This session was entirely focused on mEducator, and was open to all attendees of the conference.

- The 2nd International Workshop on Multi-type Content Repurposing and Sharing in Medical Education” was organised and held in Plovdiv, Bulgaria, on 21st of January 2010.

- The 2nd International Conference on Virtual Patients and MedBiquitous Annual conference, organised by mEducator partners was held in London, UK, on April 26-28 2010. This conference provided a number of partners to share their experience and learning from mEducator with the wider medical e-learning and technical standards community.

- Special tracks on Technology Enhanced Learning in Medical Education within the Computer Based Medical Systems Conference (CBMS) were organised in 2009 (USA), 2010 (Australia), 2011 (UK) (all sponsored by mEducator).

- Linked Learning 2011: 1st International Workshop on eLearning Approaches for the Linked Data Age, 29 May 2011, co-located with the 8th Extended Semantic Web Conference, ESWC2011 (sponsored by mEducator)

- The “E-education and E-science” International Conference organised by MU-Plovdiv, held in Plovdiv, Bulgaria, on 05-06 October 2011 (sponsored by mEducator)


- 5th Interactive Urology School – with the Institute for the Study of Urological Diseases, Portaria, Pilio, Greece, 26-29 April 2012 (facilitated/powered by mEducator technology).

7.2 mEducator Spring School

The consortium also organised a “mEducator Spring School” in Thessaloniki in April 2012. This was the 1st International Spring School on “Medical Education Content Sharing Technologies” which was widely disseminated through the web (http://www.mei2012.org/spring-school).

The programme included:

- some short theoretical keynote lectures
many practical (hands-on) sessions

Ask the expert sessions

all of direct practical and methodological importance for state-of-the-art medical teaching and education research.

Some 50 Participants from all mEducator target groups attended the school, which also provided opportunities for clustering with other projects (e.g. MORMED, Kaleidoscope, LOD, DBPedia, etc).

Finally the school facilitated online reporting by experts through the “Rapporteurs blog”:
http://www.mei2012.org/rapporteur-blog

Its evaluation by participants was rated as excellent as seen below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>The whole programme was tiring</td>
<td>2.38</td>
</tr>
<tr>
<td>Duration/timing of sessions was proper</td>
<td>3.88</td>
</tr>
<tr>
<td>The room/space was suitable</td>
<td>4.92</td>
</tr>
<tr>
<td>The room/space was comfortable</td>
<td>4.71</td>
</tr>
<tr>
<td>Assistance/help provided by facilitators...</td>
<td>4.71</td>
</tr>
<tr>
<td>Handouts and material was useful</td>
<td>4.33</td>
</tr>
<tr>
<td>Interaction was good</td>
<td>4.38</td>
</tr>
<tr>
<td>The type of sessions was appropriate</td>
<td>4.35</td>
</tr>
<tr>
<td>I would attend it again</td>
<td>4.62</td>
</tr>
<tr>
<td>Topics covered were useful</td>
<td>4.42</td>
</tr>
<tr>
<td>Overall interesting</td>
<td>4.50</td>
</tr>
</tbody>
</table>

**7.3 MEI 2012**

Many of the project outcomes were also disseminated through the 1st International Conference on Medical Education Informatics organised by AUTH and SGUL in Thessaloniki, Greece, between 6-7 of April, 2012. (http://www.mei2012.org). The conference included:

• 4 Keynote lectures
4 Tele-presentations
2 Parallel Workshops
OKFN – Greek Chapter meet-up parallel event
8 main tracks/spaces
1 poster session

It was attended by some 130 participants. The video streaming of the organised conference can be found here (needs Windows Media Player):
mms://video.auth.gr/kedea_MEI_2012A and
mms://video.auth.gr/kedea_MEI_2012B

Both the Spring School as well as the MEI 2012 Conference through facebook, twitter and live streaming, and used interactive tools for the online live rapporteuring, live voting, commenting and rating.

7.4 YouTube presence
The main project videos are also disseminated through the YouTube channel “meducatorproject”.

The mEducator YouTube Video
The main project presentation uploaded there had attracted some 500 views within the first two weeks time since its initial upload. Similar dissemination channels are open through the project website (see below) together with the final multimedia project presentation:

The Final Project Presentation is downloadable through:

http://www.meducator.net/files/D9.15a-MultimediaMEducatorProjectPresentation.ppt

Finally, let us mention that participants in MEI 2012 and the mEducator Spring School widely used the platform mEducator3.0/MELINA+ for dynamically linking and transforming presentations and web site resources into educational resources. A specific mEducator3.0/MELINA+ teaser was developed just for this purpose as shown in the snapshot below:
7.5 Sustainability

Key sustainability aspects of the mEducator work include two main areas, namely, the technical and the organisational (Authority) one:

**Technical Sustainability:**
- All nodes of technological outcomes have at least one redundant copy.
- Redundant servers are provided, located and maintained by different partners than the primary.
- All redundancy is supported with automatic updating.

**Sustainability Authority:**
- Openness of all outcomes.
- Standardization of the metadata Schema; an application has been forwarded to MedBiquitus.
- The formation of mEducator Partnership beyond the project and for a minimum period of five years (see figure below).

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**An illustration of the mEducator partnership and sustainability plan**

8 Conclusion and Further Work

To summarise, Web2.0, or else the social web, a term coined in some 6 years ago, has highlighted the importance of openness, social collaboration and participation, social networking and crowd intelligence.

Recent advances in the semantic web front, have shed light and emphasis on the notion of linked data, which basically concerns the publishing of structured data so that it can be interlinked more effectively and hopefully become more useful.

By fusing the above concepts together in mEducator we have managed to unite or federate learning management systems and open educational repositories together, so that educators and learners can organise, repurpose, re-use and share medical educational resources.

Different platforms have been created to enable this endeavour. In so doing, pivotal role has played the mEducator ontology, which has been designed to provide a consistent data scheme, across the various mEducator instances. As the platforms get enriched with educational content, resource discovery, retrieval, sharing and reuse becomes more complicated. Consequently, advanced search features are needed to avoid content duplication and assist the learners in conveniently locating relevant content.

The experiences registered so far and the best practices we elicit from the mEducator work are going to shape the involved communities of practice in the next few years.

On a final note, some of the key innovative points in mEducator consist of the following:
• The first real combination of social media technologies (Web2.0) and the semantic web (Linked Data/Web3.0) into education and learning (Linked Learning / Linked Medical Education)

• The exploitation of the role semantics may play in education and learning

• The wide use of Open source and the creation of multiple platforms

Obviously work will continue in many of the above areas. One of the impressive ones though may include the semantic searching of resources in Second Life, as powered by mEducator technology. A short video demo of the 1st mEducator island in Second Life may be reached here:

http://youtu.be/okBxQCtv4og