Information Systems and Technology for Organizations in a Networked Society

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Chapter 15
Creating Educational Resources for Medical Education in the Web2.0/Web3.0 Era

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ABSTRACT

The accelerated development of the networked society throughout the last few years had a strong impact on the teaching and learning activities from the medical related domains. E-learning applications have become very popular and encouraged the shift from traditional training activities – having the teacher as a mediator, towards self-guided ones where the teacher is rather a supervisor. These changes imposed the creation of new, more complex and more interactive teaching resources, with high quality standards, that could fulfill the requirements of the new approach. At present, the lack of specialized development tools requires the involvement of both medical and IT specialists in the resources creation process, consequently, generating higher production costs. In this chapter, the authors present two specialized tools – MetaMorphosis+ and eGLE – together with a new resources development methodology based on the repurposing approach and the blend of social networks activities with semantic web functionalities. In addition, the authors describe the user evaluation activities performed over the MetaMorphosis+ application and the results obtained.

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INTRODUCTION

The networked society, the social structure based on information and communication networks that process and distribute information on the basis of the knowledge accumulated in the nodes of the networks, is what currently boosts the change towards a knowledge economy. This emphasizes the need for new approaches to learning and a transformation of the education model in formal and continuing education alike which is strongly supported by information and communication technologies, what usually comes under the collective term of 'e-learning.'

E-learning has evolved from early stand-alone multimedia applications, through experiments of supporting remote teaching via the Internet, to recent integrated approaches where the Internet and especially the Web is used as a means to create active, context based, personalized learning experiences. This last generation of e-learning shifts the emphasis from 'teaching' to 'learning' and from the notion of technology as a didactic mediator to the notion of a sociable, peer-supported, involved learner.

E-learning environments are currently used widely in different domains of formal education and in all sorts of networked organizations. Medical education is drawing much attention, due to its special characteristics (Kaldoudi et al., 2010). Firstly, it is a field that encompasses not only the fundamental issue of education, but also the sensitive issue of health and health care services. Furthermore, education in medicine is multidisciplinary and rather long, involving a good number of academic years and extending to life-long continuing updating and learning. Additionally, medical education is traditionally based on a two-fold model: theoretical instruction based on textbooks and clinical practice with one-to-one interaction. Finally, one should stress the current enormous expansion in medical and biomedical knowledge, which constitutes a fundamental challenge in medical education. As a result the necessity for overspecialized learning material and educators is central in contemporary medical education.

In fact, during the last few years, a large amount of teaching resources are being developed in the medical field, especially due to the increasing number of cross-domain research innovations. The development of new educational material is however a rather costly activity (Dietze et al., 2013), especially due to the high standards requirements in information quality, user interaction techniques or data presentation methods (images, videos, interactive 3D models, simulators etc.). Furthermore, many of the medical specialists lack the advanced technical knowledge that is required to develop this kind of resources, and usually cannot contribute in the desired manner to the e-learning environment. Reusing some of the already existing materials in order to create new ones, has proven to be an effective solution (Wang et al., 2007), but implies often an extensive research for identifying these resources. This approach helps medical experts to concentrate more on the information quality rather than technical related problems during the creation of the resources.

This chapter elaborates on current trends and challenges in medical education as this is supported by advances in the Web, such as participative social Web technologies and semantic Web and linked data. As an indicative example, the chapter also presents a novel approach for describing and sculpting the profile of an educational resource through the blend of its social attributes and Web semantic capabilities, so that this enriched profile can be used in the context of creating new resources based on repurposing of existing material. In this approach, existing applications are integrated to support seamlessly the entire process of generating and/or repurposing and finally publishing educational material in health sciences so that such material can be retrieved and consumed by learners and/or other educators. The eGLE application, a specialized e-learning content development tool, is described briefly in the context of creating new teaching materials through repurposing activities. The approach presented here also addresses the issue of search and retrieval of disparate resource repositories based on semantics and linked data approaches as provided within the MetaMorphosis+ semantic social network for sharing medical educational resources. Finally, an evaluation of the environment by the intended consumers is included.

The structure of the chapter is as follows. The Background section includes a synopsis of current state in areas related to this chapter fields, namely (a) the area of medical education as this is supported by the internet; (b) the concept of educational content repurposing and how this has been supported by information technology; and (c) the first attempts to support education via emerging semantic technologies. The following section presents issues, controversies and problems in the area of medical educational content repurposing, highlighting the need for meaningful and relevant educational content search and retrieval on the Web as well as the need for support in repurposing existing educational material. The next chapter presents a novel integrated approach that supports seamlessly the entire process of educational content creation via repurposing to publishing including semantic interlinking and search and retrieval. A discussion is presented and some conclusions are drawn in the last two sections.

BACKGROUND

Medical Education in the Networked Era

Traditionally, medical education was based on theoretical lecturing/experimenting on basic sciences followed by clinical practice in large groups of students. Recent advances in our understanding of the learning processes however suggest that learning should evolve from learning by acquisition to learning by participation. Therefore current educational approaches rely on situational learning and are more active, self-directed, student-centered, and experiential (National Research Council, 1999). A fundamental idea is that learning should be organized in small student groups, where students actively work with reality-based situations to formulate problems and learning needs that will guide their further studies. Using library resources, text books, databases, laboratory work, field studies, lectures and other forms of faculty resources, they are urged to find answers to and perspectives on their problems and learning needs (Ehlers, 2007; Fyrenious, 2005). In higher medical education, educational programs increasingly include case-based or problem-based learning, different small group instructional models and collaborative organizations, to support student-faculty interactions, and technology-enhanced educational tools (Jones et al., 2001). The emerging view is of learning as an active, constructive, social., and self-reflective process (Berliner & Calfee, 1996). As a result, emphasis now shifts towards autonomous, specialized and self-administered educational resources that can be used by teachers and learners alike in this process of active, self-guided learning.

Technology has been employed in diverse ways to support different levels and paradigms of the educational process. At first, efforts focused on stand-alone dedicated technological solutions, thus producing educational resources that could not be shared amongst applications or users without important modifications. This was a major setback for trainers, who were bound to a specific e-learning system with limited functionalities and did not have the ability to easily distribute their materials into new platforms. Thus, the recent trend is towards educational material freely available online, what is currently generally described under the term Open Educational Resources (OER), and is becoming a common objective for universities and research communities. One of the largest and diverse collections of OER can be found in the GLOBE (Global Learning Objects Brokered

Exchange, http://globe-info.org/) where jointly, nearly 1.2 million learning objects are shared. Repositories implement different approaches for data publishing: KOCW (http://www.koreabrand.net/), LACLO (http://www.laclo.org/) and OUJ (http://www.ouj.ac.jp/eng/) for example expose a single collection of metadata instances with a common provenance while other repositories such as ARIADNE, LRE (http://lreforschools.eun.org/), OER and LORNET (http://www.lornet.org/) expose the result of the aggregation of several metadata collections that have different provenance.

However, this publishing process raises a number of issues, particularly with respect to Web-scale metadata interoperability or legal and licensing aspects. Therefore, a number of standards have been developed for content packaging and sharing, like Learning Object Metadata - LOM (IEEE, 2002), IMS Content Packaging (IMS, 2004), Sharable Content Object Reference Model – SCORM (ADL, 2009) Dublin Core (see also Koutsomitropoulos et al., 2010) and others. However, currently available metadata sets mostly describe simplified technical/structural characteristics of learning resources, lacking very important pedagogical related information like the nature of learning activities in relation to the knowledge states that may result, or the thinking processes stimulated by the activities entailed by the resource (Jonassen, 2004). Thus, more complex models and conventions for properly describing learning objectives and/or the learning context are needed (Rehak, 2003).

At the same time, the constant development of the Networked Society and the new self-guided learning approaches demand the integration of new types of data presentation that support new user interaction techniques that are more engaging and efficient, for a better information analysis. For example, projects like eTrace (Gorgan et al., 2007), Web-Trace (Giordano & Leonardi, 2007) or Dokeos (http://www.dokeos.com/) have researched on graphical annotation based user interaction with teaching materials, while other platforms are experimenting on voice based communication.

Although in the resource presentation part of the e-learning systems and in data sharing capabilities important advancements have been recorded, tools specialized in creating highly interactive learning resources are very few. Most of the applications used in medical teaching materials development have been created for other purposes (ex. HTML editors, image processing applications, 3D modeling software, etc.) and require technical skills from their users or are restrictive and limited in functionality (i.e. it is very difficult to specify the interaction techniques available to students). At the same time, none of these applications provide a solution for creating new materials through repurposing or for managing and describing the repurposing process.

Educational Content Repurposing

'Repurposing educational content' means transforming a learning resource initially created for a specific educational purpose in a specific educational context in order to fit a different new purpose in the same or different educational context. Therefore, the term *repurposing* needs to be distinguished from the term *reuse* which refers to the reuse of an educational resource "as is" (Meyer, 2006).

The majority of activities in the field of e-learning to date have focused on reuse of complete educational content items with a fixed combination of structure and content. While the value of this approach is not disputed, critical issues of deep, conceptual understanding, a sense of ownership and wider issues of cultural assimilation remain unresolved. These issues alone can determine the success or failure of educational innovations, regardless of technical robustness, accessibility and quality of content. Thus, it has been argued in the literature that fully supported opportunities for teachers to 'repurpose' object structures through a participative design process is the path most likely to lead to the elusive goal of reuse of digital learning objects by a critical mass of teachers (Gunn et al., 2005). Next to the lower production costs, the creation of new materials based on the repurposing approach has also the benefit that it can provide automatically valuable information about the new resource in terms of context, quality, related domains and specialties, pedagogical approaches and so on.

Medical educational content repurposing can be of a variety of types (Kaldoudi et al., 2009):

- Repurposing in terms of the actual content (add, change, or mutate content);
- Repurposing to different languages;
- Repurposing to different cultures (taking into account local medical regulations, different lab tests norms, reference values and units, as well as cultural differences of various national healthcare systems);
- Repurposing for different pedagogical approaches (e.g. accounting for content transformation from conventional teaching methods to active learning);
- Repurposing for different educational levels;
- Repurposing for different disciplines or professions;
- Repurposing for different delivery technology (such as digital format, digital size and quality, metadata description scheme, computer platform, etc.).

Usually, when creating a new resource through repurposing procedures, more than one of these contexts is used at the same time. Saving and tracking this information in the resource metadata description, together with some specification about how the changes have been applied, will provide valuable information about the new material: quality, user interactions, pedagogical approach etc. Moreover, through the repurposing history it can be easily identified how and where a resource has been used to create a new one or what series of transformation have been applied to which resources in order to obtain the current version of a certain learning material. To some extent, repurposing history codifies also information related to similar resources through the idea of common ancestor, enabling a very specific exploratory search that could return quickly relevant results.

Traditionally, content repurposing research has been an issue in multimedia content industry, where the term mainly refers to changes necessary to accommodate different and heterogeneous display devices (Singh, 2004). When repurposing is addressed in the broader sense as presented above, main efforts so far are targeting the automatic process of learning resource repurposing. A representative example refers to the common case of creating a new slide presentation out of a repository of related presentations (Zaka, 2008). A central issue in related studies is the model used (if any) to describe the content, the level of aggregation and packaging of an educational item. Indeed, the structure and composite nature of a learning content item is still open to interpretation (Blatsoukas, 2008), though different research activities on ontologies have been conducted to address this issue. The ALOCoM ontology (Jovanović et al., 2005) is such a representative example of an attempt to provide an explicit vocabulary and a conceptualisation of the structure and aggregation level of learning content. It defines a learning resource as a collection of content fragments and content objects, although it does not specify the role and position of a learning object in the learning content hierarchy. This ontology is then used to build a framework that disassembles slide presentations and then re-organizes the resulted components into more meaningful object types (e.g. definitions, examples, references, introductions, summaries) in an automatic way.

Presently, the perspective of domain specific ontology for learning object management is commonly adopted. A prominent example in this sense is the ARIADNE project, which has put a lot of effort to enable educational content sharing and reuse. However the final result has proved to be a complex and hard to use system, as it basically reflects the metadata standard rather than the characteristics, aims and requirements of the end user (Najar et al., 2005).

One of the new approaches for content repurposing issues has focused on drawing from Web 2.0 notions and technologies to provide a different solution. For example, social tagging has been proposed as an alternative approach to content organization, search and retrieval in educational content repositories (Dahl et al., 2008). Another similar approach is exploited in the MURLLO project, where Web 2.0 technologies are employed to create an integrated framework for effective repurposing of reusable learning resources. In this implementation a wiki is proposed for the seamless authoring and repurposing of learning content (thus allowing storage of content and all its versions), while additional services allow metadata creation for its learning resource and support searching (Wang et al., 2007).

Through repurposing, a teaching resource can be continuously improved and adapted to new requirements, it can be extended and transformed in a new and better learning material. Usually (but not always) the adaptation and/or improvement process of an existing resource require less effort than a full development activity from scratch, so a higher efficiency can be obtained with lower costs. However, this approach may be influenced by the intellectual property rights (IPR) license of the resources to be repurposed, their quality and the IPR of the new resource. As most of the repurposing activities are expected to be carried out not directly by the authors of the resources but by their colleagues and medical research community members, the legal aspects are very important to consider while the enrichment of the available resources database is a vital condition in further collaborations.

Semantic Web and Education

Given the wealth of educational resources (original and repurposed) that are continuously provided in the Web in disparate repositories, seamless and meaningful search and retrieval becomes a major burden. Current advances in semantic technologies, though, are becoming the key for tagging information with descriptors that then can be organized via predefined domain models (ontologies) and thus used to interlink data sets in meaningful and context based ways.

The most recent development of the Semantic Web is Linked Data (Bizer et al., 2009) which has successfully established a set of principles to expose data and metadata on the Web and has led to the widespread availability and use of schemas, vocabularies and data sets spanning across all application domains. In the conventional Web, a resource can be described via an XHTML/XML document, where various tags are used to annotate the document, mainly regarding its presentation, not conveying any semantics about the resource itself. In order to describe a resource, the W3C Resource Description Framework (RDF) is commonly used to represent metadata about a resource in the form of triples: subject, predicate, object. Generally, the subject can be the resource itself while the predicate can be any relationship as defined in any XML namespace published on the Web. The object can be an explicit value, but also a dereferenceable URI. This way, an RDF triple can link the description of a resource with other sources of information on the Web, thus creating a worldwide graph-like linking of resources.

Regarding the presence of educational information in the linked data landscape, two types of linked datasets need to be considered: (1) datasets directly related to educational material and institutions, including information from open educational repositories and data produced by universities; (2) datasets that can be used in teaching and learning scenarios, while not being directly published for this purpose.

Regarding the first type of datasets, initiatives have emerged recently using linked data to expose, give access to and exploit public information for education. For example, The Open University in the UK was the first higher education establishment to create a linked data platform to expose information from across its departments that would usually sit in many different systems, behind many different interfaces (see http://data.open.ac.uk which includes around 5 Million triples about 3,000 audio-video resources, 700 courses, 300 qualifications, 100 Buildings, 13,000 people (Zablith et al., 2011). Many other institutions have since then announced similar platforms: University of Southampton (http://data.southampton.ac.uk), University of Oxford (http://data.ox.ac.uk), University of Muenster, the Norwegian University of Science and Technology and others. In addition, educational resources metadata has been exposed by the mEducator project (Mitsopoulou et al., 2011; Dietze et al. 2012). More information about the educational Linked Data can be easily discovered on the Linked Education platform (http://linkededucation.org).

The second type of education related datasets includes resources related to research in particular domains, and the related publications, for example the PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) database of citations and abstracts for life sciences scientific publications, which covers more than 21 million citations, in 800 million triples.

The problems connected to the heterogeneity of metadata can be addressed by converting the data into a format that allows for implementing the Linked Data principles (Bizer et al., 2008). The approaches applied for creating links between datasets can be fully automatic, semi-automatic and fully manual. A lot of tasks required for interlinking and enhancing (enriching) metadata can be automated by analyzing textual content using Information Extraction (IE) and Natural Language Processing (NLP) techniques. Most commonly this includes the detection of sentences, named entities, and relationships, as well as disambiguation of named entities. However, quality control implies that the process has to be supervised at some point. The links can be created manually; alternatively the automatically detected links can be approved manually. Public services such as DBpedia Spotlight (http://dbpedia.org/spotlight) and OpenCalais (http://www.opencalais.com) offer NLP services relevant for linking data and also provide their output in RDF.

CREATING NEW RESOURCES THROUGH REPURPOSING

Issues, Controversies, and Problems

As the training through e-learning applications is more widely used in medical domain every day, the requirements for better, highly interactive and challenging resources are becoming imperative. While the role of the teacher shifts from knowledge mediation towards guidance, and the approach most students use today is focused on self-guided learning, the teaching resources must meet higher standards in aspects as content quality, multimedia presentations and user interaction techniques. Notions presented must be clearly illustrated while virtual experiments and further research directions should be provided for better understanding. But the development process of valuable teaching resources is an expensive one. Creating high quality videos, 3D models, interactive environments and even some well documented text articles require a great amount of effort and time.

Early research in educational content repurposing is still not addressing the need to keep track of a learning resource evolution, in order to (a) give credentials to original authors and sources; (b) provide information that may have implications for the object's quality, validity, specificity, etc.; (c) record and resolve intellectual property rights issues of content as it is being repurposed and reused; and (d) update a learning resources, or a fragment of it, when its parent object is updated, changed, terminated, etc. Implemented as semantic connections between the new resource and the initial ones (parent resources) these pieces of data provide initial quality information and also ensure that all the legal rights have been respected (as they can be verified back until the first resources in the chain). The repurposing history provide also the necessary support for graphical visualization of the history of one resource, which will enable faster and more focused search activities.

The creation of new teaching resources through repurposing is a process that mainly consists of the following general steps:

1. Search and acquire meaningful existing learning materials. This requires that existing educational resources are somehow exposed in the Web in a seamless way and that advanced search mechanisms are available.
2. Repurpose found material into the new teaching resource and then publish this resource so that its repurposing history can be tracked and exploited while the derived resource is available for use and re-use.

Solutions and Recommendations

This section describes a novel integrated approach that covers the entire aforementioned process of creating new resources via repurposing of existing medical educational content.

Searching and Retrieving Existing Educational Resources

Searching for existing learning materials can be a challenging task due to the large amount of available information over the Internet and also because of the difficulty in quickly identifying relevant and good quality resources. Another issue is that many of the valuable materials are stored in closed LCMS systems, that are not accessible to search engines or other automated content discovery applications. As a consequence, even if resources are under Creative Commons or similar licenses, they cannot be discovered easily, unless their authors manually describe them in specialized portals and discovery systems.

Our approach to these problems has been focused mainly on two directions: the development of a metadata description schema and the creation of a generic "plug-in" mechanism that allows the batch integration of already created repositories into a centralized and unitary search mechanism.

The metadata description schema developed in mEducator project (MDC, 2012; Mitsopoulou et al., 2011) is specialized on describing medical teaching resources and enables the discovery, retrieval., sharing and repurposing of educational content in the medical domain. The schema addresses different aspects of the resource, from general elements (e.g. title, description, authors, reference to the resource) to pedagogical aspects (learning outcomes, knowledge level, pedagogical approach, etc.), specialized technical information (media types included, technical recommendations), legal information (IPR license) and also repurposing related data (what resources have been used in the creation of a new resource).

Based on the implementation of this schema for describing teaching resources, we have developed an e-learning platform for sharing medical educational content, named MetaMorphosis+ (Dietze et al., 2011). As particular social characteristics of the resources can provide valuable information about the quality of a resource (Kaldoudi et al., 2011) (for example, how it was used and rated by the users, what kind of resources are similar, etc.), the functional organization follows the paradigm of social networks. More specifically the social association of users and educational objects follows a novel approach of a heterogeneous symmetric network of both humans and resources (Kaldoudi et al., 2011a).

Thus for the end user, MetaMorphosis+ can be viewed as two distinctive and interacting networks. The first one is a conventional network of persons, including authors, potential authors and final users of educational resources (students, or teachers or others, e.g. educational managers, etc.). The second is a network of published educational resources with interactions with other learning resources as well as with persons. These interactions are variable and dynamic, thus create an evolving, user centric and goal oriented organization of resources and persons, based on social dynamics.

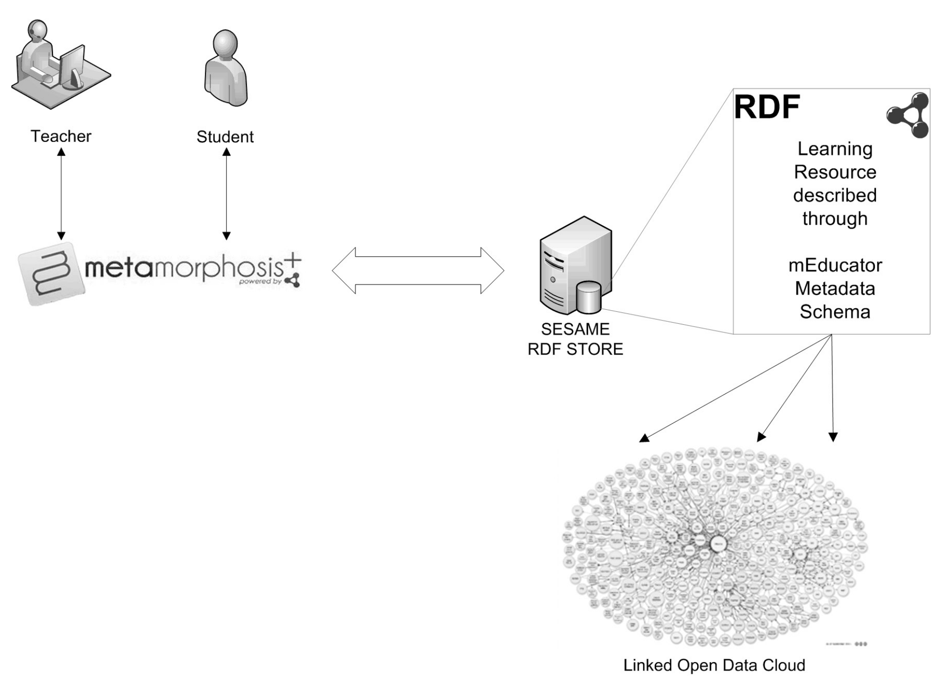
The network of persons is functioning in a way similar to other social networks. Persons can interact with each other via their personal blogs, declare friends and create their own interest groups. At a different level, learning resources themselves create an equivalent social network with interactions with other learning resources as well as with persons. These interactions are variable and dynamic, thus create an evolving, user centric and goal oriented organization of resources and persons, based on social dynamics.

From the point of view of the resources' social network, interactions are more complex. Each resource is described by a variety of fields that capture its basic characteristics as well as features pertaining to repurposing. This collection of fields forms the resource profile and is a virtual representation of the resource in the social network of resources. Educational resources are distributed, and they can reside anywhere on the Web (e.g. within a Learning Management System, another on-line repository, a Web page, etc), as long as their URL is known. MetaMorphosis+ only holds their metadata description and the pointer to their actual Web location.

The metadata descriptions are provided by the users and are further enriched with semantic information gathered from the Linked Data Cloud (LOD) and stored in a SESAME RDF framework (Dietze et al., 2012; Yu et al., 2011), in an approach aimed to maximize search results relevance (see Figure 1). This enrichment process is a semi-automatic one, implemented in two main phases:

- The first enrichment phase takes place under the total control of the user, who is pro-

Figure 1. Resource profile in MetaMorphosis+



vided with the functionalities needed to query the BioPortal API through the MetaMorphosis+, searching for a keyword in all the available ontologies. The results are then returned to the user, who has the possibility to select the desired entries and create semantic connections in the schema for the keywords, disciplines and discipline specialties attributes.

- The second enrichment phase takes place after the user has submitted his description and is done automatically. By analyzing the user provided content for the metadata, in the Sesame repository the application performs clustering actions that create supplemental connections between the resources.

As a result, any resource in MetaMorphosis+ has a profile created from blending the social information with semantically enriched data. This complex representation allows better search results and enables new ways of data harvesting like exploratory search based on similar attributes of the resources (Marchionini, 2006). When a specific resource is considered appropriate (e.g. image, video, 3D model, serious game etc.), the user has the possibility to save the direct reference of the material, which is usually a URL.

A central notion in the environment is the hierarchical organization of resources in ‘families’ describing the repurposing history of each resource. Each repurposed resource declares its parent resource(s). Following iteratively the ‘parents’ in a chance of repurposing ancestors, the entire ‘family’ tree of the particular resource can be compiled. A force-directed graph is used to depict the specific resource’s family and inheritance patterns. Each node in the graph represents a resource, while the directed edges represent repurposing relationship, with the arrows pointing from the “source” objects to their “repurposed” descendants. The nodes also state the ‘repurposing context’, while they are active links to the resource profile where more information on the repurposing description can be obtained. For the entire resource collection, a circular directed graph representation depicts all the resources with the various individual inheritance trees.

This complex social structure is implemented based on the open source ELGG Social Network Engine (Elgg Foundation, 2012).The MetaMorphosis+ environment is available as open access (subject to self-registration) in http://metamorphosis.med.duth.gr and today hosts more than 400 educational resources (with more than 80 repurposed ones) submitted and used by more than 900 registered users.

Integrating Available Resource Repositories

Except for the OER initiatives described above, most of the e-learning resources created to date are stored in isolated learning content management systems (LCMSs) and therefore they can be used only in the context of a specific institution. Although their license would permit repurposing and redistribution activities, the resources are not discoverable through regular search activities. As already explained in previous sections, most of the exchange solutions implemented in today’s platforms are focused on resources packaging and importing, not on exposing the metadata about the resources for search engines, data portals or other automatic discovery applications.

Addressing this problem, MetaMorphosis+ provides a solution for easily integrating a large number of already existing resources stored into an external platform. Although this integration does not create a complete profile for the resources, it allows the medical specialists to easily discover quality materials that are not available anywhere else, directly through the interface of MetaMorphosis+. This approach comes as a quick alternative solution to the manual integration of each resource into the MetaMorphosis+ application, a process that would require a considerable amount of time and effort for a large number of resources.

In order to qualify for integration, any repository must meet the following minimal requirements:

- Provide some meta-description information about the resources, in any consistent format (following DC, LOM or other schema, even a custom developed one).
- Include in the description clear information about the license of each resource.

Traditional ways of managing metadata often take a document-centric approach and use XML as it is an established standard for expressing information. Transformation of metadata into other formats requires a thorough mapping to be crafted, which often involves an analysis of the exact semantics of the involved standards. When included into the platform, each repository is described semantically to provide general information about the published resources: languages, domain, specialties etc. This information has an important role on deciding if a specific provider will be queried at a certain search action initiated by the user (for example if the user looks for resources available in a different language than the ones published by the provider).

The results returned are initially codified in the metadata description schema used by the providing repository and are later converted on the fly by our platform into the mEducator Metadata Schema. There are situations where the conceptual model of the origin data cannot be directly mapped to the RDF model and information may be lost. To avoid such situations, RDF should be considered as a basis for metadata interoperability – a common carrier – when adapting existing or creating new metadata standards. Although the metadata conversion does not provide full information about the resource it is necessary to ensure a unified user experience throughout the entire MetaMorphosis+ application, and to display the search results in a consistent format. Nevertheless, without the support of a complete resource profile similar with the one presented in the previous section, it will be more difficult for the user to identify the valuable resources.

Repurposing Retrieved Material to Create New Learning Resources

The process of creating new teaching resources, either from scratch or through repurposing procedures, involves usually a certain level of technological knowledge. Depending on the complexity of the representations included in the materials (videos, 3D modeling, serious games etc.) their creation or adaptation could require a higher involvement from an IT specialist rather than from a medical one. All these reasons increase the cost for teaching material creation and also represent a very important issue when comes to the development of highly interactive resources that could be more suitable for better presentation of certain types of information.

For some of the repurposing types described in the previous sections we propose a solution that allows a medical specialist to repurpose previously created elements (images, videos, 3D models, interactive quizzes etc.) in new resources, without the necessity of low level technical intervention. The profile of our target user has the following main characteristics:

- Is a medical specialist that intends to create e-learning content for his/her trainees.
- Possesses knowledge about the basic concepts of teaching materials and e-learning environments, including basic understanding of user interaction types, pedagogical approaches, information presentation methods, etc.
- Has no (or very little) technical knowledge about technologies like HTML, CSS, XML, JavaScript, etc. or concepts like distributed databases, mash-ups, web services and others.

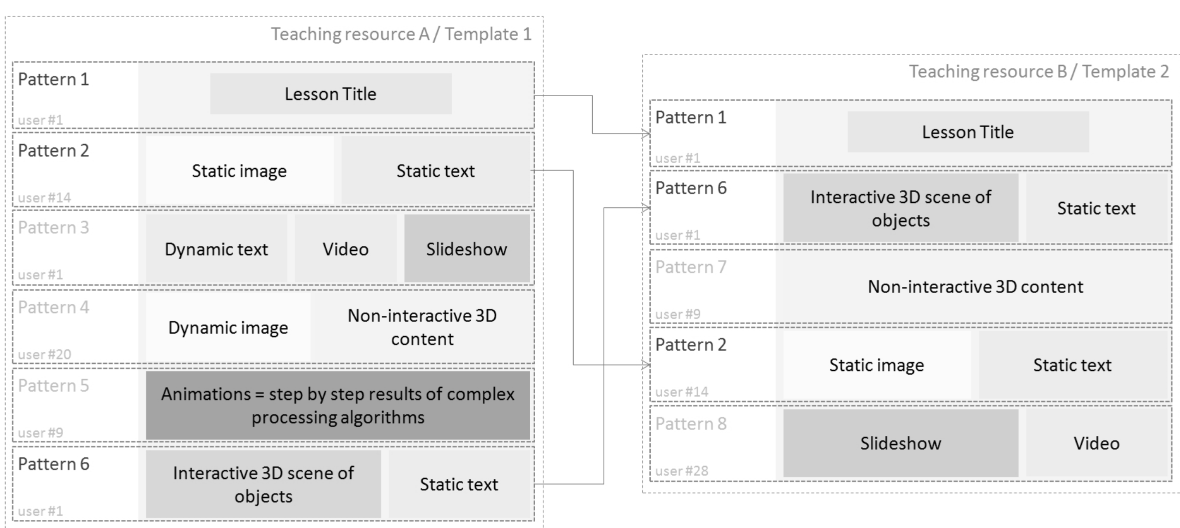
- Has medium level computer operating skills that include internet browsing, basic knowledge about file formats (ex. image formats), files management operations, etc.

After the required existing material has been identified, the trainer can login into the eGLE application (Ştefănuţ et al., 2010) that will provide the necessary functionalities for data retrieval and visual information representation. The architecture of the application is based on the combination of two conceptual models:

- **Client-Server Model:** Necessary for a better control over the resources of the platform and for data integrity and consistency maintenance procedures. It provides all the basic functionalities necessary in an eLearning application (ex. operations for users, courses and resources management etc.) together with the tools integration, instantiation and management mechanisms. This centralized data management model allows a very strict and accurate information control into the platform and therefore reduces significantly the maintenance costs.
- **Distributed Architecture Model:** Used to achieve a greater extensibility and scalability. Implemented at the tools level, this model provides increased flexibility when it comes to data storage, acquisition and processing. Each tool instance works independently of all the others in the resource and has the ability to connect itself directly from the client computer (e.g. the student computer) to an external data-source or specialized service (Grid processing, graphics cluster visualization, etc.).

The visual structure of an e-Learning Resource described in eGLE is presented in Figure 2. At the template level the general format attributes for all the content is specified (default text size and color, background settings, etc.). One can specify a unitary display aspect for the entire resource. On the next level, the visual structure is composed by patterns, which are logical containers that represent one row into the template and group related information: picture and its description, 3D model and a related video presentation, etc. One pattern can hold one or more tools, which are the atomic elements of the eGLE visual structure.

Figure 2. Repurposing content in eGLE application



Each tool provides a specialized interface for data retrieval (ex. over HTTP, from an FTP connection, from a web service etc.) data type presentation (image, video, 3D model, text, etc.) and implements specific user interaction techniques (ex. graphical 3D annotation, text formatting functionalities, etc.). All trainers have the possibility to create new patterns and add tools to them through drag and drop interaction. Later, the patterns can be repurposed or reused as many times as necessary either in the same resource or in different ones, by the same author or by his colleagues (see Figure 2).

Through eGLE functionalities, the teacher has the ability to retrieve automatically the resources found at the previous step by providing only the identifier in the form of a URL. Then, through the available tools, the platform allows the integration of this content in any section of a learning resource, the reuse of the data in the same or in different materials, and offers the ability of selecting different user interaction techniques over the same content, even in the same resource. For example, if the same 3D model is integrated in a material in three different sections, for each section the trainer can specify different user interaction techniques: no interaction for the first instance (the user can only view the model), visualization control for the second (the user can change zoom level, rotation or translation) and graphical annotation based user interaction for the third instance.

Describing the New Created Resource via Standards

After the creation process has been finalized, the teacher has the possibility to publish his new resource towards his colleagues by describing it through mEducator Metadata Schema. This purpose can be easily achieved through MetaMorphosis+ application as it provides the visual interface and the necessary mechanisms to create a complete resource description:

- mEducator schema taxonomies integration (for defining media types, resource types, learning outcomes etc.).
- Dedicated interface for creating semantic connections towards the LOD in the keywords, disciplines and discipline specialty properties. The terms will be selected by the user from specific ontologies, while the connection details (reference numbers etc.) will be automatically handled by the application.
- Specialized user interface for creating repurposing related connections between the resources, for defining repurposing contexts and describing the changes that have been made.
- The possibility to reference other learning resources as companions, using only their URL.

Through this metadata description, the resource will be indexed into the platform and will be made available to the other users with an initial set of information and with some properties "inherited" from the original resources. The profile will be enriched through social characteristics over time, building the complete description of the resource.

One very important aspect to be considered here is the license chosen for the new resource. The author must verify that he/she conforms with the licenses of all the involved materials, going back through all the repurposing history (if he hasn't done that already). Another important role of IPR license is the direct influence it has on the availability of the resource, not in terms of accessibility but in terms of repurposing to new resources.

At the same time, the educational aspects of each teaching resource must be accurately and completely described as they provide implicit and valuable information about the pedagogical approach, educational objectives and outcomes, educational level or prerequisites required to understand the materials. Using this highly specialized information, any teacher can perform a more efficient search activity identifying faster the suitable resources for their needs.

User Evaluation of the MetaMorphosis+ Application

A user evaluation study was conducted to access the acceptance of this environment by the end consumer, namely the learner who wishes to find and use relevant educational material. For this purpose, MetaMorphosis+ was evaluated via 2 focus groups (a total of 28 users) consisting of undergraduate medical students. The participants were briefly introduced to the idea and overall approach and were presented with two use case scenarios designed to assess the activities of searching for an educational resource and also for describing a resource along the provided metadata fields. A structured questionnaire was used (http://metamorphosis.med.duth.gr/lime/index.php?sid=85896), followed by an overall semi-structured conversation, mainly concentrating on positive and negative aspects of the environment and suggestions for improvement.

Overall the study highlighted that the application was well accepted, since more than 75% felt that is was easy to use and well integrated and only 21% found it complex, while 32% indicated that they felt prior knowledge was needed before getting started with using it. Metadata describing the resource was found to be helpful (by 63-79%) and easy to understand (only 4% reported difficulty in understanding it). Also, the amount of metadata was found to be adequate (14% found the amount to be excessive, while 32% found it insufficient). However, the educational content itself was not judged as adequate; 30-50% of the participants were neutral in terms of content adequacy, while only 25-28% reported that the educational content they managed to find was useful and adequate for their information needs.

The discussion clarified that most of participants were satisfied with locating a wide range of content types (i.e. not only conventional educational material, but also serious games, virtual patients, and other interactive content), but the actual amount of content items related to a range of subjects was rather inadequate. Also, the majority reported that for subjects with lots of educational objects, the search process was rather slow. Actually, only 13% were satisfied from the search response time, although more than 75% reported that the search mechanism was easy to understand and use. Overall, around 74% of the participants indicated that they would recommend the application to their colleagues.

User Scenario on Creating a New Teaching Resource

Preparing for a class on liver pathology, the teacher decides to improve his online teaching materials with more references, pictures and multimedia elements. He logs into MetaMorphosis+ and verifies the list of personal published items from his account. On the second page he can find his current version of the course, published more than a year ago – one of the first contributions he has made to the platform under Creative Commons license. Opening the detailed page of this resource, he displays the repurposing history and quickly observes that his course has been repurposed several times by different community members.

While browsing through the repurposed items he encounters many different repurposing types: for different educational levels, to different cultures, for different disciplines or professions and even for different pedagogical approaches. Reading the short description of the repurposing process, the teacher selects from the list only the elements that provide new multimedia materials, as this is what he is interested about. He saves the URL references of the chosen resources into a file on his hard-drive and then quickly performs in

MetaMorphosis+ two advanced searches on the terms “liver” and “liver pathology” selecting as desired resource types “Figure/Diagram/Picture,” “Serious game” and “Video.”

As the order of the results is established through a blend between the relevance of the item for the search conditions and the social aspects of the resource’s profile, the teacher identifies quickly the best available materials that could be used in his class. Being under time pressure, he decides to choose this time only materials that have clear IPR Rights and do not require explicit agreement from the authors. Therefore, he selects from the interesting elements found only the ones with “Attribution,” “Attribution-share-alike” and “Attribution-non-commercial-share-alike” licenses, saving their URL in the document opened before.

Being satisfied with the materials found, the teacher logs out from MetaMorphosis+ without making an extended research in the external resource repositories, an action that would require more time but could provide other interesting findings. He authenticates into eGLE application and opens his course for editing. The application loads the current content in edit mode, meaning that each tool displays a specific interface that allows data source specification, content formatting and user interaction settings.

Opening the URL of the resources created through repurposing from his current version of the course, the teacher decides to make only small changes to the text content, adding some more references and a few paragraphs about new remedies found. In this purpose he adds two instances of the text tool and positions them through drag&drop to the desired positions. Then he formats the text using the Microsoft Word similar functionalities and decides to take a look over the new multimedia materials selected.

He finally chooses a couple of images and three video files that he finds interesting. But now, another problem arises: saving all the files on the server is not possible because his account is very close to the maximum storage limit. However, the teacher is not very concerned as he is aware that eGLE application provides functionalities of accessing on the fly data resources from remote locations. So he normally continues the edit actions by inserting the necessary instances of the image and video managing tools and providing them the URL’s previously saved. Everything is accomplished through the visual interface of the application, without any programming or scripting required. Automatically, the external resources are loaded and displayed into the tools.

As a final step, the teacher configures the tools with the desired user interaction techniques. For example, the first video will start playing immediately when the resource is accessed, as it is a short, introductory presentation. The other video files will be manually controlled by the students at runtime. Also, one of the chosen images is a very large file with many details that cannot be visualized properly in the available space in the course. At the same time, next to it, the teacher has inserted explanatory text that should be easy to consult at any time when analyzing the image. As a result, the teacher uses the Settings interface of the tool to grant his students the ability to interact with the image by resizing and repositioning it directly into the space reserved, without opening a new window.

Satisfied with the result, the teacher saves all the changes and logs out from eGLE, having in mind to publish later his new version of the course on MetaMorphosis+, for the entire community. By connecting his new resource with all the included elements from the network he will provide other teachers valuable information about the repurposing activities performed and the quality of the new material.

FUTURE RESEARCH DIRECTIONS

Following the continuous development of today’s networked society one can envisage that the tremendous quantity of information that is already shared will continue to increase exponentially. It will thus become more difficult to digest all the information and, even more important, to identify good and valid data. As presented in this chapter, learning resources are no exception to this trend. More and more repositories are published each day and become available to search engines in an unstructured and unverified form from pedagogical perspective, thus representing a potential threat to the self-directed learning process.

MetaMorphosis+ approach described here proposes a solution that combines semantic web functionalities with different social characteristics, in order to create a complete profile about each resource that provides efficient information which is partly verified and enhanced via the semantic enrichment and linking. Through the mechanisms of generic repository access, a large amount of data can be quickly connected to the search mechanisms, although with minimum information. One of the future research directions is aimed at improving the generic automated generated profile obtained from the remote repositories in order to provide more useful information to the user. This way, repurposing activities will be easier to perform and high quality teaching resources can be created more efficiently.

One of the most important aspects in the development of our solution is the evaluation received from the target users, namely the medical specialists. The continuous user evaluation of the applications is a necessity that will be extended also on the eGLE platform. Furthermore, we are doing research on the automatic integration of MetaMorphosis+ social and search capabilities with eGLE functionalities aiming to create a specialized and unitary development environment that will better assist all medical trainers in creating new e-Learning teaching resources.

CONCLUSION

The self-guided learning represents today an approach widely used and encouraged in medical domain. The continuously improving e-learning applications encourage this type of study and support both students and teachers throughout the pedagogical process. Nevertheless, high quality teaching materials are mandatory for a correct and efficient instructional process, which leads to higher costs for the development of these materials. Furthermore, due to the lack of dedicated tools for learning resources development, medical specialists need technical assistance during the process.

The development of new medical e-learning resources through repurposing methods represents a viable solution for creating valuable and high quality resources at lower costs. One of the major challenges on this approach is to identify relevant materials that can be reused. For this purpose we have presented MetaMorphosis+ that blends the social information about a resource with semantically enriched data, for a more relevant search results organization.

As the next development phase, the trainer needs to apply the repurposing activities on the selected elements, action which usually requires advanced technical knowledge. As a possible solution we have described the eGLE application, that offers specialized functionalities for data retrieval., user interaction setup and information presentation. Furthermore, the platform allows the medical specialist to define his own layout and control its structure in an interactive and visual manner, without requesting any technical knowledge.

The tools integrated into eGLE application have been specifically designed for e-learning resources development. The main compositional activities are implemented through drag&drop user interaction and no coding is required for placing different elements in a certain position, resizing actions, common formatting or data retrieval from remote addresses. The development and integration of these tools into the eGLE application cannot be done without assistance from IT specialists. However, as most of these tools are generally purposed (e.g., handle any type of image, handle video files, handle text etc.) and not linked with a specific instance of data (e.g., one specific image, one specific video file etc.), they can be reused without other technical intervention.

Through the use of the specialized applications presented in this chapter medical specialists have the possibility to create high quality learning resources with minimum technical knowledge and almost no intervention from IT specialists. The main concepts of MetaMorphosis+ are very similar to the ones of other social network applications while the semantic features are mostly transparent to the user who interacts with them through the friendly interface. Therefore, no specific technical knowledge is required to use this tool at its best performance. The user evaluation tests performed on MetaMorphosis+ environment confirmed its utility and 74% of the questioned subjects were willing to further use this environment in their teaching activities. Nevertheless, different issues, mainly related to performance, were also identified and will be addressed in future development activities.

As a result, through these applications medical specialists have the possibility of searching, creating and publishing high value learning resources in the medical domain, while maintaining the development costs at a low level. At the same time, students have the opportunity to explore self-directed learning by browsing through the available resources and even contribute to the community with comments, ratings, social relations or even their own teaching materials.

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KEY TERMS AND DEFINITIONS

Actor-Network Theory: A distinctive approach to social theory and research which originated in the field of science studies.

Content Repurposing: Transforming a learning resource initially created for a specific educational purpose in a specific educational context in order to fit a different new purpose in the same or different educational context.

Educational Content: Describes any content with educational value and structured to be used for teaching activities.

E-Learning: Includes all forms of electronically supported learning and teaching.

Linked Data: Describes a recommended best practice for exposing, sharing, and connecting pieces of data, information, and knowledge on the Semantic Web using URIs and RDF.

Semantic Web: Provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.

Social Networking: A social structure made up of a set of actors (such as individuals or organizations) and the dyadic ties between these actors.