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Depicting Educational Content Re-purposing Context and Inheritance

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***Abstract*—Educational content is often shared among different educators and is enriched, adapted and in general re-purposed so that it can be re-used in different contexts. This paper discusses educational content and content repurposing in medical education, presenting different repurposing contexts. Finally, it proposes a novel approach to content repurposing via Web 2.0 social networking of learning objects. The proposed social network is augmented by a graphical representation module in order to capture and depict the relationships amongst different re-purposed medical learning objects, based on educational content 'families' and inheritance. The ultimate goal is to provide a conceptually different approach to learning object search and retrieval via 'social' associations amongst learning objects.**

Index Terms— *learning object, medical education, social networking, content repurposing*

I. Introduction

CONTINOUS advances in medicine and biological sciences lead to an ever expanding core knowledge relevant to the medical practice, which in turn creates the need for the corresponding state-of-the-art educational content [1]. Indeed, a number of research projects led by large international consortiums from research and the industry are already dealing with the research issues of exchanging and sharing learning objects, in medicine and in general [2]. More specifically, the cultivation of this need lead to the newly launched, EU funded best practice network "mEducator" (funded by the European Commission under the eContentPlus2008 programme, Contract Nr: ECP 2008 EDU 418006) [3]. The mEducator consortium aims to implement and critically evaluate existing standards and reference models in the field of e-learning in order to enable specialized state-of-the-art medical educational content to be discovered, retrieved, shared and re-used across European higher academic institutions. Considering the state-of-the-art nature of medical educational content, it is imperative that such content can be repurposed, enriched, and embedded effectively into respective medical and other related scientific curricula, clinical practice and continuing education, as well as public dissemination and awareness.

This paper discusses different perspectives of content repurposing in medical education and presents a novel approach for capturing the re-purposing of medical learning objects in collaborative educational networks. Re-purposing of learning objects is described using metadata which can be edited collaboratively in a social network, either by the instructor, or the student (and eventually even by software itself). Finally, the paper proposes a graphical web-based approach for depicting educational content inheritance in terms of re-purposing context and history.

II. Educational Content Re-purposing

The term 'repurposing' refers to changing a learning object initially created and used for a specific educational purpose in a specific educational context in order to fit a different new educational purpose in the same or different educational context. Although not formally addressed as such, educational content repurposing is what any educator is routinely engaged in when preparing a new educational experience, including preparing the educational content itself. Customarily, when an educator sets the context and goals of a new educational experience, he/she will overview existing content and/or search for new relative content and then re-purpose and re-organize content to fit the purpose of the new educational experience.

There can be a variety of situations where re-purposing educational content is desired. These situations, referred to as "re-purposing contexts", can be of a pedagogical nature, a technical nature or both, and include the following:

1) Re-purposing in terms of the actual content: Add or mutate content, integrate content from different learning objects, re-organize existing content, etc. or a combination of the above.
2) Re-purposing to different languages: Especially a mandate in healthcare, as acquired knowledge should be finally communicated to the patient.
3) Re-purposing to different cultures: Can be viewed as

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content localization and includes to different legislation and local medical regulations, different lab tests norms, reference values and units as well as different medical requirements of various ethnic groups.

4) Repurposing for different pedagogical approaches: Pedagogical cultures present in healthcare education range from the conventional lecturing to clinical practice and a variety of active learning methodologies. All of these educational approaches would require the same content to be presented in a different way.
5) Repurposing for different educational levels: Content needs to be adapted to match different pre-requisites and consecutively different learning outcomes for different levels: undergraduate, postgraduate, residency, specialty training, and continuing life-long education during medical practice, public education, etc.
6) Re-purposing for different disciplines or professions: Healthcare education addresses a multitude of professions, ranging from medical doctors to nurses and lab technicians, to basic life scientists and even healthcare administrators.
7) Re-purposing to different content types: Contemporary medical education exhibits a considerable variety of content types. Thus a common aim of repurposing is to change a learning object from one type to another. For example, a lecture presentation to a didactic problem, or course notes to presentation and so on.
8) Re-purposing for different technology: Finally, we should account for changes to a digital learning object that affect its technological characteristics, such as digital format, digital size and quality (e.g. for images), metadata description scheme, computer platform, etc.
9) Re-purposing to educational content: Re-purpose content created for a different purpose to content used for education.
10) Re-purposing for people with different abilities: This includes re-purposing content for people with special needs, e.g. from written to spoken form, etc.

Considerable research work has targeted the field of automatic learning object repurposing. For example, the common case of creating a new powerpoint presentation out of a repository of related presentations [4]. In this work, the text of the PowerPoint (slides, notes pages, etc) is extracted and stored as text. Text is then parsed and augmented with tags which are used to annotate each word with its syntactical form. This approach allows the dynamic extraction of similar LOs, query by example and document-level similarity checking (at document, at topic and at a slide level). With a similar target, the ALOCOM project created an ontology for LOs and their components (types of components and relationships based on an ontology of the structure of the learning content) [5]. This ontology is then used to build a framework that disassembles ppt presentations. These components are re-organized into more meaningful object types (e.g. definitions, examples, references, introductions, summaries) in an automatic way. Analogously to the ALOCoM work, the TRIAL-SOLUTION project defines an ontology for learning objects that includes mathematical categories like definition, theorem, proof or example, with the goal to create and deliver personalized teaching materials that are composed from a library of existing documents on mathematics at undergraduate level [6]. The perspective of domain specific ontology for learning object management is commonly adopted. A prominent example is the ARIADNE project, which has put a lot of effort to enable LO sharing and re-use, however resulted in a complex and hard to use as it basically reflects the metadata standard rather than the characteristics, aims and requirements of the end user [7].

Apart from automatically re-purpose learning objects, research into re-purposing may address requirements such as keeping track of a learning object evolution, in order to (a) give credentials to original authors and sources, and provide information that may have implications for the object's quality, validity, specificity, etc; (b) record and resolve intellectual property rights issues of content as it is being repurposed and reused; and (c) update a learning object, or a fragment of it, when its parent object is updated, changed, terminated, etc. In our work, we address re-purposing as a means to provide a different view in learning object search and retrieval via associations created during repurposing.

III. A Social Network of Learning Objects

Our proposed approach to manage re-purposed learning objects draws from the Web 2.0 paradigm. The term Web 2.0 refers to the current, second generation of the Web that moves towards a collection of dynamic services and communication tools that emphasize on peer-to-peer collaboration, contributing, and sharing, both among humans and programs. One of the representative applications of Web 2.0 is social networking websites that focus on creating online communities of individuals who publish their content and activities while exploring others' content and activities.

Currently there are numerous social networks for general usage or specific groups. Probably the most famous example is Facebook (http://www.facebook.com) which has started mainly as a way for people to find past classmates and has expanded into pretty much any personal relationship. Other examples include MySpace (http://www.myspace.com), which is mainly a website for people to share their musical creations and find others with similar taste, and aNobii (http://www.anobii.com/), a site for book lovers on which they can share thoughts and list their favorite books. Badoo (http://badoo.com/) is a general social networking website mainly for European users, while BlackPlanet (http://www.blackplanet.com/) is meant for African-Americans. Epernicus (http://www.epernicus.com/) and SciSpace (http://www.scispace.com) are some of the social network platforms dedicated to scientists and researchers.

The proposed social network can be viewed as two distinctive and interacting networks [9]. The first one is a network of persons, including authors, potential authors and final users of learning objects (students, or teachers or others, e.g. educational managers, etc). The second is a network of published learning objects. 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 objects themselves create an equivalent social network with interactions with other learning objects as well as with persons. These interactions are variable and dynamic, thus create an evolving, user centric and goal oriented organization of objects and persons, based on social dynamics.

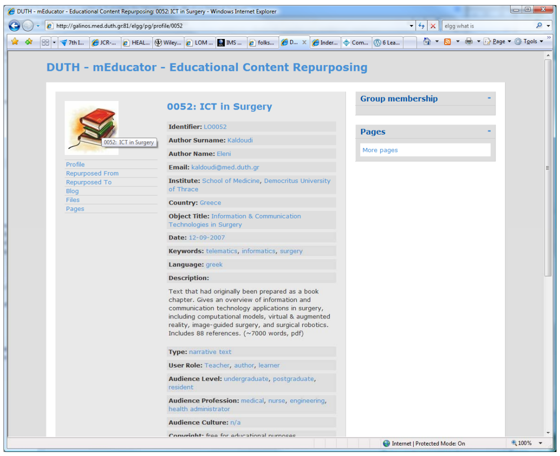

Fig. 1. Representative screen of the learning object social network showing an object's profile.

From the point of view of the objects' social network, interactions are more complex. Each object is described by a variety of fields that capture its basic characteristics as well as features pertaining to re-purposing. Basic such fields include: author and author details, date of creation, keywords (that may be free user defined tags), language, description (that is free text and may also contain user defined tags), type (i.e. exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, lecture, etc), user role (i.e. teacher, author, learner, manager, etc), audience level (i.e. undergraduate, postgraduate, resident, specialist, public), intended audience profession (i.e. medical, nursing, biology, informatics, administration, engineering, etc), intended audience culture (i.e. ethnic or national group reflected in the content), and copyright. The LO itself can be a resource in an LMS, another repository, a resource on the web etc. and its location is stated by the field URL or it can also be an associated file or files uploaded in the social network itself. The primary LOs' organization is created via the group "my learning objects" that each author creates to include all learning objects he/she has created, either as the principal author or as the result of repurposing. Then, a second complex and dynamic organization is created based on the user generated tags that have been declared for each of the LO description fields. Finally, a third type of organization is a hierarchical one, describing the re-purposing history of each object. The current deployment of this learning objects social network is implemented using the Elgg open source social engine (http://elgg.org/). A representative screen is shown in Figure 1.

IV. Depicting Repurposing Inheritance

Social networks represent both a collection of ties between people and the strength of those ties. Often used as a measure of social "connectedness", recognizing social networks assists in determining how information moves throughout groups, and how trust can be established and fostered. That has forced many scientists of different fields to try and utilize these newly found online relationships in order to extract various conclusions and conduct studies upon them to help them understand how these relationships form, develop and in what ways their participants interact. Sociologists try to apply their own knowledge to describe mainly "why" these relationships form and computer scientists/mathematicians mainly focus on the "how" the bonds are structured and what we can extract by them [8]. These methods mainly involve visual representation of the network with a graph and applying well known metrics on it, including centralization, closeness, density, radiality, etc.

Even a single snapshot of the graph depicting the social network can give a first idea of how the network is structured, which entities are connected together and especially in the case of a directional graph which entities derive from others. Such techniques are being used in commercial and research applications in order to depict relationships within networks. For example, in the Facebook social network applications like "The Nexus" (http://nexus.ludios.net/) help people see which of their friends are connected with others and thus find some new people that might be of interest. In the case of "Social Action" developed by the University of Maryland (http://www.cs.umd.edu/hcil/socialaction/) social graphs have helped to explain the voting patterns among US senators and connections between Al Qaeda members in various social networks.

Our work takes a similar approach to depict re-purposed learning object inheritance and relationship and thus provide an alternative means of navigating the space of learning objects. There are two main steps in this approach. The first involves interfacing with the particular social network instance in a standard way so as to dynamically extract data. The second part deals with the actual graph representation of the extracted data.

The standardized bridge with the social network involved transforming relationships represented in the FOAF protocol (http://www.foaf-project.org/) implemented in Elgg, to the GraphML (http://graphml.graphdrawing.org/) file format standard which is universally used to describe any kind of network graph. GraphML files are easily comprehensive

XML files describing the graph's nodes, edges and their attributes. A schematic diagram of this architecture is shown in Fig. 2. A trigger from a user through the social network interface ("Elgg Interface") spawns the dynamic creation of the required graph (GraphML file). The visualization is created through the "Graph Depict module" and provided to the end user through the "mEducator Interface module".

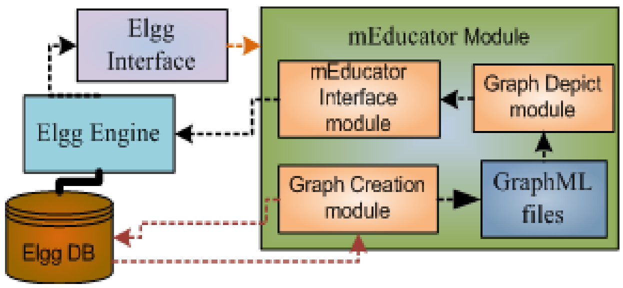

Fig. 2. Abstract architecture of the graphical representation module.

In terms of graph representation, two different graph types are employed to give different views of the network. For the entire object collection a circular graph representation is used which depicts different object families, usually not interconnected amongst them. When a certain object is of interest, a force-directed graph (with arrows pointing from the "source" objects to their "re-purposed" ascendants) is used to depict the specific object's family and inheritance patterns. Graph representation was implemented based on the Prefuse information visualization toolkit (http://www.prefuse.org).

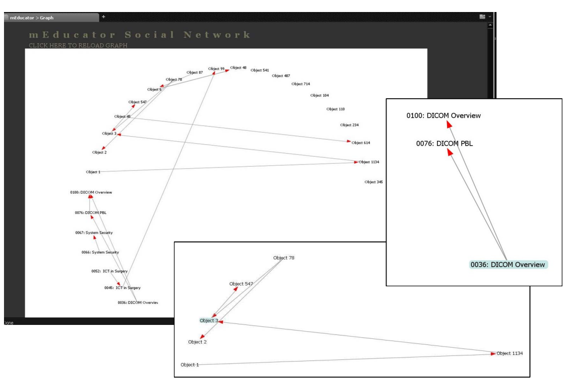

Fig. 3. Graphical representation of the entire learning object social network with the partial view of two different object families.

V. Discussion

Technology-supported educational interventions are usually successful when specific training requirements are aligned with the learning potential and the educational use of technology. Thus, requirements for flexible, adaptive and ubiquitous online content sharing should evoke notions, practices and technologies from respective state-of-the-art evolutions of the Web technologies.

The proposed approach of learning objects social networking has been deployed in order to study learning object re-purposing in medical education within the recently initialized European Best Practice Network "mEducator: Multi-type Content Repurposing and Sharing in Medical Education", under the eContentplus2008 program. The ultimate goal is to provide an alternative view of learning content organization, management and sharing for use and re-use across healthcare institutions, via 'social' associations amongst learning objects with emphasis on their repurposing history and associations.

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