VERSITA
Applied Computer Systems
2012 / 13
doi: 10.2478/v10312-012-0007-1

# Integration of the Tagging Mechanism in the Collaborative e-Learning System

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***Abstract* – The tagging mechanism is a technique that can be used to implement the personalized collaboration in the e-Learning systems, thereby increasing the efficiency of such a system. Semantic Web technologies can be used to enhance tags with machine-readable annotations to improve the accuracy of tag-based recommendation services.**
**The novelty of the proposed approach is the combined use of the Semantic Web technologies and the reuse-oriented model in the development of the e-Learning environment.**

**Keywords – tagging, e-Learning, collaborative learning, Semantic Web**

## I. Introduction

"Collaborative learning" is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product. Collaborative learning activities vary widely, but most center on students' exploration or application of the course material, not simply the teacher's presentation or explication of it [1].

Collaborative learning facilitates education, research, social cohesion, and psychological stability; thereby, increasing self-esteem, reducing anxiety, encouraging understanding of diversity, fostering relationships, stimulating critical thinking, increases student retention, and encourages group learning [2].

One of the important problems with the most of the collaborative e-Learning systems is the lack of personalization or a rather weak its implementation. Personalization is the ability of the system to adapt to various characteristics of a user or user group. Personalization technology helps users to implicitly filter large amounts of information; thereby, reducing the information overload. Besides, it provides better user experience and stimulates their participation.

The goal of this paper is to evaluate how the tagging mechanism can be used to improve personalization in the proposed collaborative e-Learning system. Most of the currently used tagging mechanisms use tags like keywords –a symbolic string. Therefore, within the framework of this paper it has been decided to find out how the Semantic Web technologies (like RDF, OWL, etc) can advance this approach and what new features they can provide. The results of this evaluation will be used in the development of the prototype of the proposed e-Learning system.

Additional attention is paid to the proposed high-level organization of the development process. The organization is based on the reuse-oriented approach that is recognized as an important mechanism for the improvement of software quality and development productivity.

## II. Related works

The Open Annotation and Tagging System (OATS) is an open source tool which was created to further enrich the functionalities provided in Learning Management Systems. The aim is to motivate learners to tag learning content by providing self-organizational tools. Further, OATS provides a method for note-taking, which is integrated directly into learning content. While it uses a traditional approach for tagging, it incorporates several other approaches based on combining web annotation systems with collaborative tagging systems that are targeted for e-Learning. OATS architecture has been designed so that it may easily be incorporated into any Learning Management System or webpage [3]. However, it seems that the development of this project has been stopped.

Kardan, Abbaspour, and Hendijanifard proposed an original algorithm for recommender systems, which utilizes collaborative filtering and uses the user's tags and concept maps as its input. The algorithm has three stages for filtering out the best recommendations. In the first filter it takes out the concept maps that have implemented the tags that have not been related in a user's concept map. In the second filter the most similar concept maps are extracted, and finally in the last filter it matches the tag space of the users to suggest the most similar tags for the user [4].

Cernea, Del Moral, and Gayo in their article titled "SOAF: Semantic Indexing System Based on Collaborative Tagging", proposed a system architecture called SOAF for the semantic indexing of Learning Objects from a repository. SOAF combines automatic techniques of information retrieval with collaborative tagging of documents made by users. In this way, the metadata of the Learning Objects provides real meaning derived from the learning practice in user communities able to share their experiences through specific annotation of the learning content, which will identify each Learning Object and will improve its reusability in new learning contexts [5]. However, currently there is only a proposition and no practical solution.

There are a number of researches describing the use of the reuse-oriented approach in the development of the learning systems. For instance, in their research Ateveh and Lockemann demonstrate that despite the differences the engineering techniques of software reuse and aspect-oriented programming can successfully and profitably be applied to courseware development, although they need to be specialized for the purpose [6].

Neither of the mentioned groups of researchers used the Semantic Web technologies to improve and advance the proposed collaborative tagging approaches. There is a lack of the information on how the use of the Semantic Web

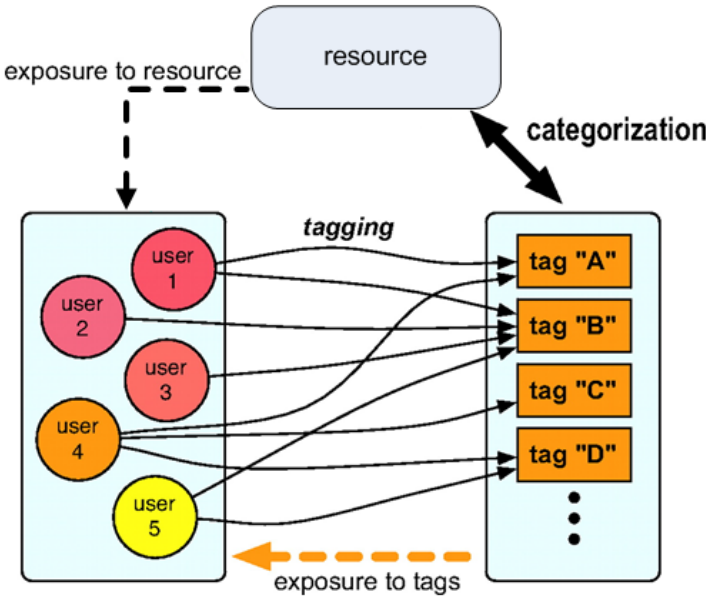


Fig. 1. Schematic depiction of the collaborative tagging process

technologies affects the reuse-oriented approach and development process in general.

## III. Collaborative Tagging

Along with the appearance of Web 2.0, it has become a common practice to associate World Wide Web resources (for example, forum posts, blog entries, etc) with "tags", which basically are human-readable labels. Tags are rather similar to "categories", but differ in that they typically are not organized in a traditional taxonomic hierarchy. Tagging is especially popular on the web sites that allow users to tag bookmarks (for example, del.icio.us), photographs (for example, Flickr), videos (YouTube), and other content.

In contrast, folksonomy (also known as collaborative or social tagging) is a system of classification derived from the practice and method of collaboratively creating and managing tags to annotate and categorize content. This means that anyone (although this may vary depending on the application) can attach keywords or tags to content. Usually the sites that support the collaborative tagging allow the users to publicly tag the available content; therefore, users cannot only categorize the information for themselves, but can also browse the information as categorized by others. Figure 1 contains the simple schematic depiction of the collaborative tagging process.

Collaborative tagging can potentially be effective in the e-Learning systems because:

- Most of the currently available learning managements systems (LMS) lack an adequate support for self-organization of the learning content;
- Collaborative tagging can be used to further enrich peer interactions and their awareness about the learning content;
- Tagging provides students with an opportunity to summarize and express new ideas, while receiving peer support (by browsing other students' tags or tag suggestions);
- The information provided by tags provides insight on learner's comprehension and activity, which is useful for both educators and administrators [7].

In their study of user activity within collaborative tagging systems, Golder and Huberman came to conclusion the prevalence of tagging with a very large number of tags and according to information intrinsic to the tagger demonstrates that a significant amount of tagging is done for personal use rather than public benefit [8]. They state, "The prevalence of tagging with a very large number of tags and according to information intrinsic to the tagger demonstrates that a significant amount of tagging, if not all, is done for personal use rather than public benefit. Nevertheless, even information tagged for personal use can benefit other users".

Tags can be viewed as the source of the information about user's interests. Therefore, performing the analysis of user's tagging activity, it is possible to build the tag-based user models and deliver the appropriate information to the corresponding users.

Halpin and Shepard outline the following three hypotheses about tags behavior over time [9]:

- Tags convergence: the tags assigned to a certain Web resource tend to stabilize and to become the majority.
- Tags divergence: tag-sets that do not converge to a smaller group of more stable tags, and where the tag distribution continually changes.
- Tags periodicity, where after one group of users tag to some local optimal tag-set, another group uses a divergent set but, after a period of time the new group's set becomes the new local optimal tag-set. This process may repeat and so lead to convergence after a period of instability, or it may act like a chaotic attractor.

Besides being used to annotate traditional information resources, tags can also perform the following functions for the bookmarks [8]:

1. Tags can identify the topics of the bookmarked items. These items include common nouns of many levels of specificity, as well as many proper nouns, in the case of content discussing people or organizations.

2. Tags can identify what kind of thing a bookmarked item is, in addition to what it is about, for example, article, blog and book.

3. Tags can be used to identify who owns the item. Some bookmarks are tagged according to who owns or has created the bookmarked content. Given the apparent popularity of weblogs among Delicious users, identifying content ownership can be particularly important.

4. Refining categories. Some tags do not seem to stand alone and, rather than establish categories themselves, refine or qualify existing categories.

5. Identifying qualities or characteristics. Adjectives such as scary, funny, stupid, inspirational tag bookmarks according to the tagger's opinion of the content.

6. Self-reference. Tags beginning with "my", like *mytext* or *mycomments* identify the content in terms of its relation to the tagger.

7. Task organizing. When collecting information related to performing a task, that information might be tagged according to that task, in order to group that information together, for instance, with *todo* or *jobsearch* tags. Grouping task-related information can be an important part of organizing while performing a task [10].

## IV. Semantic Wiki as the Basis of the Collaborative E-Learning System

Semantic wikis are traditional wiki systems empowered with Semantic Web technologies like RDF, OWL, SPARQL, SWRL, etc. The main goal of semantic wiki is to create a wiki with data in structured, machine-processable format. This is usually achieved by annotating the existing content with symbolic information that describes its meaning. For example, a link from White House to Pennsylvania Avenue NW, Washington, D.C., could be annotated with "located at".

Currently, there is the number of semantic wikis that could be used as the basis of the e-Learning system. Some of the most popular semantic wiki applications are:

• Semantic MediaWiki – is an extension to MediaWiki (a wiki software that runs all the projects of the Wikimedia Foundation, including Wikipedia, Wiktionary, and Wikinews), that allows users to add semantic annotations to the wiki pages (Semantic MediaWiki, 2011). Semantic MediaWiki, just like MediaWiki, is written in PHP (PHP: Hypertext Preprocessor) programming language. Semantic MediaWiki's basic architecture is depicted in Figure 2.

• IkeWiki – is a semantic wiki developed by Salzburg Research that allows users to annotate pages and links between pages with semantic annotations. IkeWiki makes full use of Semantic Web technologies like RDF(S) and OWL using the Jena RDF store, and is implemented as an AJAX-based Rich Internet Application, based on the Dojo Toolkit.

• OntoWiki – is a semantic wiki from University of Leipzig. Besides providing the opportunity to annotate text-based Wiki pages with a special syntax (as suggested by text-based semantic wiki approaches), OntoWiki uses RDF to represent information. For human users, OntoWiki makes it possible to create different views on data (for example, tabular representations or maps). For machine consumption it supports various RDF serializations, as well as RDFa, Linked Data and SPARQL interfaces.

Depending on the semantic annotations, wiki can change the way the content is presented to the users. These context-aware presentation features can include (but not limited to) formatted display of information derived from the underlying knowledge base, change of page style to make it more convenient for users to perform their actions (for example, to provide printer-friendly versions of the related pages), display of semantically related information in the current page (for example, in the "See also" section), etc.

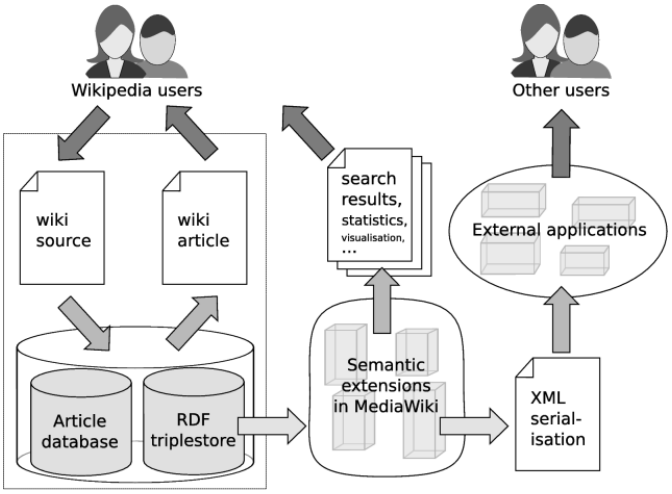


Fig. 2. Basic architecture of the semantic extensions to MediaWiki [11]

Semantic Web technologies make it possible to implement semantic search mechanism that can improve search accuracy by understanding searcher's intentions and the contextual meaning of terms. The search engines can look for pages that refer to a precise concept in an ontology instead of collecting all pages in which certain, generally ambiguous, keywords occur. In this way, differences in terminology between Web pages and the queries can be overcome [12].

Inference engines, or reasoners, are software tools that derive new facts or associations from the available information. Therefore, making it possible to create new knowledge based on the existing information. Reasoners create models of the information and relationships to draw logical conclusions based on these models. For example, using OWL (Web Ontology Language), it is possible to make inferences based on the associations represented in the models, which primarily means inferring transitive relationships [13].

Use of the Semantic Web standards (RDF, OWL, etc) makes it easier to exchange data with other application and to re-use existing data in the other projects. This approach helps to avoid many data conversion-related problems and is especially important for projects that will produce data with long-term importance.

Source [14] contains the proposal for the collaborative e-Learning system that should be able to integrate multiple semantic wikis. This is necessary because single e-Learning system can be used for multiple courses or projects; therefore, each course or project may require its own wiki. To improve system usability and students' productivity a system could include Single Sign-On (SSN) mechanism. This mechanism allows users to log at once and get access to all (sub-) systems without being prompted to log in again to each of them.

Social networks have recently attracted huge interest and according to the latest Nielsen Online reports now they are even more popular than email (see Table 1). Hence, one of the important features of the proposed collaborative e-Learning system should be the built-in rich social network. This addition should allow group members to easily organize face-to-face communications and real-time discussions for the whole group. FOAF technology support would make it possible for users to import the existing profiles and also to re-use the created profiles in the other projects with support of FOAF.

TABLE I

THE INCREASING REACH OF "MEMBER COMMUNITY" WEB SITES ACROSS 2008 [15]

| Country | Active Reach Dec 08 | Active Reach Dec 07 | Actual Percentage Point Increase |
|---|---|---|---|
| Global | 67% | 61% | 5.4% |
| Brazil | 80% | 78% | 1.4% |
| Spain | 75% | 65% | 9.9% |
| Italy | 73% | 63% | 9.9% |
| Japan | 70% | 67% | 2.7% |
| UK | 69% | 59% | 10.3% |
| USA | 67% | 64% | 2.6% |
| France | 67% | 64% | 2.9% |
| Australia | 59% | 55% | 4.9% |
| Germany | 51% | 39% | 12.5% |
| Switzerland | 51% | 41% | 9.6% |

Blogging has become an integral part of the social Internet; therefore, it is necessary to let students express their personal opinions in the blogs. Other students could not only read those blogs but also leave comments regarding some of the described issues or proposed ideas.

Thus, social networks and blogs can help students to develop the bonds and trust with team (or course) members and improve team relationships. Use of these social tools helps to supplement face-to-face encounters.

To reduce the possibility of interference between different learning groups and copying of other groups' work, it is necessary to implement an access control system. This system should allow the administrator (who most likely is also the teacher) to modify project status. For example, if a project is public, everyone has at least read-only access to the information within this project, but in close/private projects only group members and teacher have the access to the information.

Once a group finishes the task (completes the project), project status can be changed from close to public; thereby, making it possible for other students to use the information from particular wiki in their studies. Depending on the purpose and type of project, it can be provided as read-only or as free for all to edit.

In the next chapter, the authors will discuss how a collaborative tagging mechanism could be used in the proposed system (and collaborative e-Learning systems in general) to solve the personalization-related problems.

## V. APPLYING THE SOCIAL TAGGING MECHANISM TO THE PROPOSED COLLABORATIVE E-LEARNING SYSTEM

Even though collaborative e-Learning is currently one of the most popular e-Learning approaches, there still are the issues that need to be addressed. Some of these issues are related to the lack of the proper implementations of the personalization and recommendation features in the collaborative environment.

Tags can be used to propose recommendations to the user according to his preferences, visited resources (user history), and tags in the current resource. These tag-based recommendations can be very important and helpful because they can reveal additional content that is related to the currently viewed page. Besides, the recommendations can help users to make a choice from a large number of possible alternatives once they are ranked according to the degree of similarity with the currently visited page.

There are different ways how to implement tag-based recommendations. The simplest approach is to check that recommended pages share at least some of the tags with the currently viewed page or resource. There is no further similarity processing in this simplified approach; therefore, the list of recommendation is not ranked. The biggest advantage of this method is the performance – the system only needs to retrieve the tags and compare them. However, some pages may share just a single tag, which does not necessary mean that they are somehow related. Therefore, it is important to consider constraints for this approach.

Another and a far more advanced approach is to use multiple parameters (factors) to find the similarity between the resources. The list of the parameters can include the following:

- Tag popularity – indicates how frequently the tag is being used,
- Tag representativeness – indicates how distinctive the tag is to the resource.
- The importance of a tag for a user.

The parameters can then be used to calculate the quality factor for the particular tag and to define its position in the tag list for the particular resource.

Of course, this approach can also be used to filter the search results and provide the users with the resource that includes the same tags as the search query or specific settings in the user's profile.

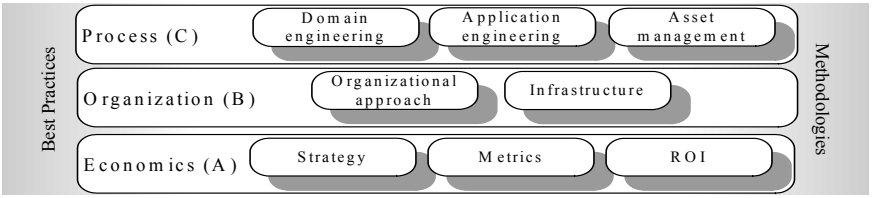


Fig. 3. The overall structure of reuse-oriented framework [19]

Many of the currently used tagging systems implement tags as the symbolic strings. However, this approach is not very descriptive and limits the expressiveness of such a system. It is possible to implement some kind of taxonomy for textual tags, but it most likely will result in weak semantics and poorer performance of the system. Semantic Web technologies can be used to describe the tags in the form of concepts (ontologies). Therefore, it will be possible to work with a meaning of a tag instead of a less informative symbolic string.

This addition can greatly improve the ease of finding the semantically related information (tags) and the accuracy of quality calculation procedure.

Developers can use their own ontology vocabularies to better reflect the situation in the particular domain. However, to avoid problems with conflicting vocabularies for the same domains it is suggested to use already available vocabularies. Should it become necessary to improve or to supplement the vocabulary with the new information, the developers can contact the experts who are responsible for the maintenance of the public vocabulary, thereby, avoiding possible collisions.

The use of SWRL (Semantic Web Rule Language) provides an opportunity to define the rules that reflect some specific requirements. SWRL is based on a combination of the OWL DL and OWL Lite sublanguages of the OWL Web Ontology Language with the Unary/Binary Datalog RuleML sublanguages of the Rule Markup Language [16]. It enables Horn-like rules to be combined with an OWL knowledge base. SWRL has been adopted by W3C as the representing standard for production ontology-based rules.

Wiki environment makes it easier to implement social recommendations that can be used as another means of communication between the users in the system, where they can exchange information and share knowledge. Judging by the results from the analysis of social and behavioral aspects of tag-based recommendation systems [17], it can be suggested that the recommended content items can be ranked according to their social capital value.

## VI. Reuse-oriented development of the e-learning system

Proposed approach for the organization of the development process of the collaborative e-Learning system is designed according to the following main conclusions derived from the results of our survey in [18]:

• Organizations should focus on the development of product families if applicable in the operating business area.

• 72% participants claimed to succeed in projects by the means of software reuse in their organization.

• Attention should be paid on the introduction of process-driven systematic reuse in the organization.

• Organizations should consider using repository for storing and retrieving reusable assets, and a configuration management process should guarantee proper evolution of these assets.

It is suggested to rely on the process dimension of the reuse-oriented framework proposed by the authors in [19]. The overall structure of the framework as outlined in Figure 3 is organized considering economic (A), organizational (B), and process (C) aspects of reuse.

Process-driven means that the software development is done in accordance with well-defined processes that are enforced through management policies. A software process could be defined as a set of activities that lead to the production of a software product [20], and it is important in order to ensure efficiency, reproducibility, homogeneity, and predictable time and effort constraints. A key concept of such reuse-oriented approach is the domain, which may be defined as an application area (e.g. e-learning domain) or, more formally, a set of systems that possess similar functionality and share design decisions. By domain-specific reuse we assume that the reusable assets (like "biofeedback" monitor and effectors' modules), the development processes, and the supporting technologies are appropriate to the application domain for which the software is being developed.

To support reuse in the collaborative e-Learning system development, the process adhered has to consider two facets: developing for reuse and developing with reuse. As a result, comparing to conventional "monolithic" set of tasks organizations are responsible for providing and maintaining software systems, software reuse introduces a differentiation between the tasks related to the production of reusable assets and the tasks related to the production of end-user applications [21]. Such two-life-cycle approach with generalized activities schematically displayed in Figure 4 is commonly referred to as domain and application engineering, which addresses development for reuse and development with reuse respectively.

From the technical point of view, the e-Learning system provider within the proposed framework should consider implementation and support of the artifacts related to the different e-Learning modules as part of the domain engineering process, while product line approach should be considered for the application engineering cycle. Semantic Web and Internet-based technologies discussed in the previous section aimed to provide a facade in order to support such

reuse-oriented approach for the collaborative e-Learning system development.

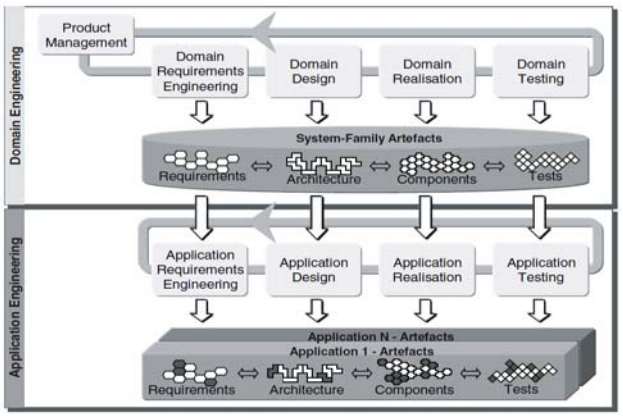


Fig. 4. The two-life-cycle model of domain and application engineering [22]

## VII. Conclusions

After studying the possibility of the integration of the collaborative tagging mechanism in the proposed collaborative e-learning system, the authors have come to the conclusion that the correct use of this technique can greatly improve the attractiveness and ease of use of the system for the end-users. This approach can be effectively used to enable the personalized collaboration in the proposed e-Learning environment; thereby, remarkably increasing the efficiency of the system and its attractiveness to the users.

The novelty of the proposed approach is the combined use of the Semantic Web technologies and the reuse-oriented approach in the development of the e-Learning environment.

The Semantic Web technologies can be used to perform the inference on the available information and to derive new facts or associations from the existing information, to semantically annotate learning objects using standard data description languages and formats, and to implement semantic search mechanism that can improve search accuracy. This would also greatly improve the accuracy of quality calculation procedure; thereby, providing the users with the semantically related results.

Use of controlled vocabularies provides an opportunity to reflect requirements of a particular domain in a more efficient and flexible way. However, they should be used with caution to avoid compatibility problems in the future.

Use of the W3C approved Semantic Web standards like RDF, OWL, and others, makes it easier to exchange data with the other applications and to reuse this data later in the other projects.

The reuse-oriented approach should be considered an important mechanism for the improvement of software quality and development productivity.

## VIII. Future work

At the moment. the design phase of the project has been finished and the development of the proposed e-Learning system is ready to start according to the reuse-oriented approach.

## IX. Acknowledgments

This work is partly financed by the European Union (European Regional Development Fund) within the Baltic Sea Region Programme 2007-2013 project BONITA (Baltic Organisation and Network of Innovation Transfer Associations). This research has been supported by the European Social Fund within the project “Support for the Implementation of Doctoral Studies at Riga Technical University”.

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