ReMashed – Recommendation Approaches for Mash-Up Personal Learning Environments in Formal and Informal Learning Settings

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Abstract. This article presents the ReMashed system that recommends learning content from emerging information of a Mash-Up Personal Learning Environment. ReMashed offers advice to find most suitable learning content for individual competence development of lifelong learners. The ReMashed system was initially designed to offer navigational support to lifelong learners in informal learning settings. In this article we want to discuss its ability to be used also in formal learning settings. For this purpose, we discuss the use of two different recommendation approaches for formal and informal learning within ReMashed.

Keywords: recommender system, mash-up, personalization, personal learning environments, MUPPLE, informal learning, emergence, formal learning

1 Introduction

The networked Knowledge Society is more than ever empowered by the Web2.0 development efforts. The so called Web2.0 lifted the barrier of adding information to the Internet and enables people to contribute information to the Internet. This also applies to lifelong learners who use the Internet to find suitable information for their learning needs. They also take advantage of Web2.0 tools to create, share, and use learning activities.

Nowadays, Internet users and lifelong learners can take advantage of services like *iGoogle* or *Netvibes* to create a personal view on information they are interested in. *iGoogle* and *Netvibes* are Mash-up Personal Environments that allows their users to add and combine different information sources of the Internet at one place. Further, by integrating Web2.0 services like *Blogs*, *Delicious* or *Slideshare* the user can follow other users and integrate social networks into such a Mash-up Personal Environment. Consequently the concept of Mash-Up Personal Learning Environments is also applied to support learning. They are called Personal Learning Environments (PLEs) [1] or Mash-Up Personal Learning Environments (MUPPLEs) [2].

MUPPLEs initially support informal learning as they require no institutional background, curriculum structure, and are free of use. Their focus is on the learner independently from institutional needs like student management or assessments. Although, they are most appropriate for informal learning, educational scenarios are thinkable where MUPPLEs become integrated into formal learning like in universities as well. In an even more complex manner the existing of MUPPLEs force universities to open up their environments and services to MUPPLEs [3].

The possibilities of the Web2.0 tools and Mash-Up Personal Environments increase the amount of information available on the Internet and enables people to access almost anything they need. On the other hand, the Internet opens the door for a plethora of information that makes it difficult to get an overview and to select the most suitable information. This selection problem also applies to lifelong learners who get lost on the Internet. The learners can be overwhelmed by the information they receive or they might have problems selecting the most suitable learning content for their personal competence development.

Promising technologies to support people, in order to navigate to the most suitable information, are recommender systems. They are successfully applied at e-commerce web sites like *Amazon.com*, where people receive recommendations based on the products they are interested in. The recommender system matches customers with a similar taste of products and creates a kind 'neighborhood' of like-minded customers. It looks for related products purchased by the neighbors and recommends these to the current customer. This navigational support by recommender systems may help us to reduce time and costs involved in selecting suitable information on the Internet. It will help learners in selecting learning content according to their individual needs, preferences and learning goals.

This article presents the ReMashed system, a MUPPLE that exists out of mashed information from Web2.0 services and a recommender system that offers advice to find most suitable learning content for individual competence development of lifelong learners. The ReMashed system was initially designed to offer navigational support to lifelong learners in informal learning settings. In this article we want to discuss its ability to be used also in formal learning settings.

In the following section we present first related work on MUPPLEs (section two). Afterwards we present the ReMashed system in version 1.0 (section three). After that we present two recommendation approaches for using ReMashed either in formal or informal learning settings (section four) and finally discuss future research (section five).

2 Related work

Nowadays, 'mashing' information becomes a widely used activity on the Internet. In order to get an overview of conducted research on MUPPLEs we created a Mindmap that shows related research topics around MUPPLEs [1].

[1] The Mindmap can be found at http://www.mindmeister.com/15237440/r-d-on-mupples. Feel free to join us and further extend it.

We identified three main research fields on MUPPLEs: 1. Pedagogical scenarios, 2. Use case studies, and 3. Technology Development. Surprisingly, research field 3 – Technology Development contains most of all published articles. Because of the size of this article we can hardly discuss all related research efforts. Nevertheless, we want to give some examples for each research field and recommend to have a look on the online version of the Mindmap.

According to research field 1, there are multiple pedagogical scenarios thinkable a good example for using a MUPPLE in formal learning can be found in [3]. They present an approach how universities can take advantage of MUPPLEs. An example how MUPPLEs support informal learning can be found in [4]. For research field 2 – Use case studies, we have to point to [5] where four experiments with MUPPLEs are reported. According to research field 3 – Technology Development, various efforts are published. For instance [6, 7] have different approaches to make the development of MUPPLEs more end-user friendly, further [8, 9] try to improve the information interoperability between widgets in MUPPLEs.

The ReMashed system belongs to research field 3 – Technology Development of MUPPLEs and extends the already existing developing efforts with recommender system research. It offers navigation support for lifelong learners to meet most suitable learning content in Mash-Ups. The combination of different Web2.0 services to recommend information based on mashed tag and rating data was not done so far and especially not for learners in MUPPLEs. Thus, ReMashed offers a new approach by mashing data of users from various Web2.0 services to provide tailored recommendation to them.

3 The ReMashed System

In order to test different recommendation approaches for MUPPLEs we designed the ReMashed environment that enables lifelong learners to add their Web2.0 sources to the ReMashed community. The system allows the learners to personalize emerging information of a community to their preferences. They can rate information of the Web2.0 sources in order to define which contributions of other members they like and do not like. ReMashed takes the preferences into account to offer tailored recommendation to the learner. It uses collaborative filtering [10] to generate recommendations by matching together learners with similar opinions about learning resources. Each member of the system has a 'neighborhood' of other like-minded learners. Ratings and tags from these neighbors are used to create personalized recommendations for the current learner. The recommender system combines tag and rating based collaborative filtering algorithms in a recommendation strategy. Such a recommendation strategy reacts on certain situations by using the most suitable recommendation technique. We tested a prototypical version of the system (Version 0.9) in an usability evaluation in a group of 49 users from 8 different countries [12]. The evaluation phase ran for one month and was concluded with an online recall questionnaire. In that timeframe 4961 contents were collected, 420 resources were rated and 813 recommendations were offered. The overall satisfaction with the system was positive. The participants suggested particular improvements we took into account for ReMashed release 1.0 (see Fig. 1). The goals of ReMashed and a detailed system architecture can be found in [11]. Currently, Version1.0 supports the Web2.0 services *Twitter*, *flickr*, RSS feeds from *Blogs*, *slideshare*, *delicious*, and *YouTube*.

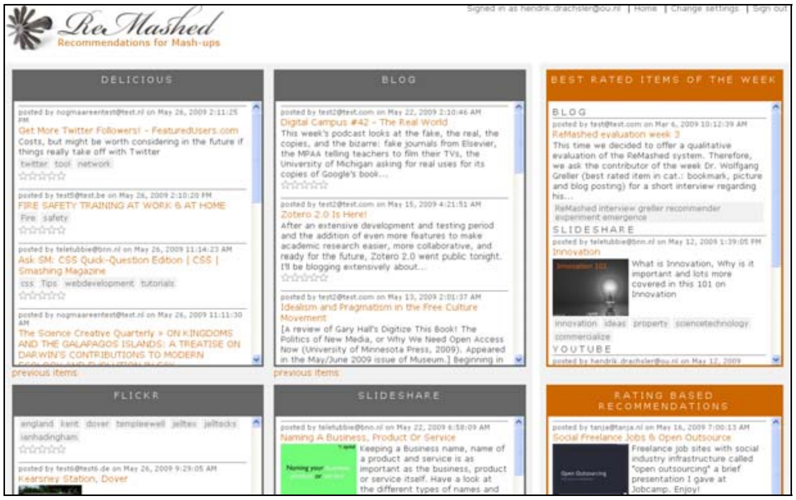

Fig. 1. The user interface of the ReMashed 1.0. On the left side, the mashed information from delicious, blogs, flickr and slideshare are shown. On the right side, the recommendations for the current learner are presented.

In order to support the learners with suitable recommendations for learning we extended the user profile with a learning goal specification and related knowledge level definition. The learners can specify three main learning goals with their current knowledge level. They can specify their knowledge levels in a self-assessed way (see Fig. 2).

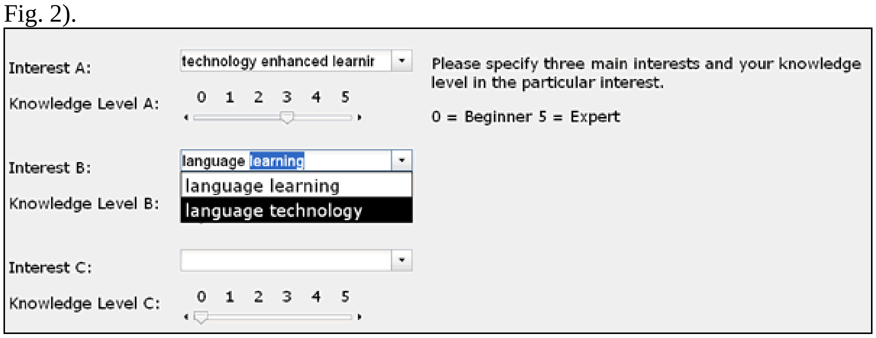

Fig. 2. The learner profile of the ReMashed system. The learners can specify three main Interests (learning goals). Further, they can indicate their knowledge level in the particular learning goal in a self-assessed way (from 0 Beginner – 5 Expert).

We supported the learning goal interface by a simple auto-suggest / auto-completion algorithm [13] which can be fed by different technologies like ontologies, metadata, existing tags, or already entered learning goals of other learners.

Initially ReMashed was designed to support lifelong learners in informal learning processes but as Web2.0 is also an important topic for companies and universities we want to explore the application of ReMashed also for formal learning settings. Therefore, ReMashed can be further developed for information dissemination and managing tasks within organizations. Because organizations often have classified information more restricted tools for information sharing are needed. Free accessible Web2.0 services that are open to the Internet can hardly be applied for this purpose. Thus, a kind of closed IntraWeb2.0 solutions (own blogging or twitter system) could be used within the organizations to strengthen the knowledge dissemination. The produced content could emerge in similar interfaces like the suggested ReMashed system, without fearing to lose classified information to third parties. In addition, companies or universities might have more restricted learning goals than individual lifelong learners. Therefore, we have to adjust the recommendation approach to certain conditions of formal and informal learning settings.

In the following section we discuss the changes in recommendation approaches to support formal and informal learning settings with ReMashed.

4 Recommendation approaches for formal and informal learning settings

Different recommendation needs can be identified when considering the use of Technology-Enhanced Learning (TEL) to support different educational settings like formal and informal learning.

Formal education, being usually organized according to some curriculum, traditionally occurs in teacher-directed environments with person-to-person interactions. Informal learning is described in literature as a learning phase of so called lifelong learners who are not participating in any formal learning context (like universities or schools). Lifelong learners are acting much more self-directed and they are responsible for their own learning pace and path [14]. In addition, the learning content for their learning might come from many different sources: expert communities, work context, training or even friends might offer an opportunity for an informal competence development. The learning process is also not designed by an institution or responsible teachers like in formal learning, but it depends to a large extent on individual preferences learners have or choices that learners take.

Depending on the learning settings, the aims of TEL systems, their environmental conditions, and the tasks that they support also change. Thus, considering the way TEL context variables vary according to the adopted setting, the information needs of the targeted users change. This can greatly affect the design of recommender systems for different TEL settings. In the following sub section we suggest recommendation approaches for formal and informal learning settings. We especially focus thereby on the learning goal interface and its related knowledge levels in ReMashed. Both approaches can feed the learning goal interface (see Fig. 2) to embed pedagogical reasoning into the recommendation.

4. 1 Recommendation approach for formal learning settings

Many recommender systems for formal learning like [15] using fine granulated knowledge domains and can therefore offer personalized recommendations to the learners. They can use metadata and ontologies to define the relationships, conditions, and dependencies of learning resources and learner models. They can take advantage of well structured formal relationships like predefined learning plans (curriculum) with locations, student/teacher profiles, and accreditation procedures to recommend courses or personalize learning.

A promising solution to apply the learning goal functionality of ReMashed for formal learning settings is the work on adaptive sequencing [16]. It takes into account individual characteristics and preferences for sequencing learning content. Adaptive sequencing needs three abstraction layers to add semantics between content and possible learning goals. On the top layer, the learning goal layer, a hierarchy of learning goals needs to be modeled. In the second layer, the conceptual layer, ontology of domain concepts needs to be created. The lowest layer, the content layer, contains the actual content of the learners. With the adaptive sequencing approach organizations can pre-structure and control the available learning goals within the system. Further, they can easily adjust and cluster the learning goals and their related knowledge level to their needs.

This approach requires a maintenance effort as there are many design activities needed before the runtime and also during the maintenance of the system. In addition, the knowledge domains in the learning environment need to be described in detail. These aspects make the adaptive sequencing approach not applicable for informal learning settings.

4. 2 Recommendation approach for informal learning settings

In order to apply ReMashed for informal learning settings, we need different recommendation approaches. The absence of maintenance and structure in informal learning settings is also called the ‘open corpus problem’. The open corpus problem applies when an unlimited set of documents is given that cannot be manually structured and indexed with domain concepts and metadata [17]. For instance, learning goals in informal learning settings are a rather diffuse parameter because they rely on information given by the learners without any standardization.

To handle the dynamic and diffuse characteristic of learning goals and related knowledge levels probabilistic techniques like text driven *latent semantic analysis* or mining techniques like *hierarchical clustering* are promising. They are appropriate for informal learning settings because they require nearly no maintenance and improve through the emergent behaviour of the community. ReMashed is not a purely text based system, as it uses videos and pictures as well. Therefore a purely text-driven approach is rather inappropriate. Most suitable therefore is the *hierarchical clustering* method. It builds up a hierarchy of items by continuously merging the two most similar items / groups into a new group. In the ReMashed case, an item is a single blog posting or a picture with related tags. We can create a measure for most frequently used keywords for each blog or picture by simply using words counts. The similarity between items / groups can then be measured by similarity measures like Euclidean distance or the Pearson correlation. In each iteration the method calculates the distance between every pair of items / groups and the closet ones are merged together to form a new group. This process is repeated until there is one group with various sub groups. In that way hierarchical clustering creates a kind of automated ontology on top of the available contents.

Similar like the adaptive sequencing approach this automated ontology can be fed into the learning goal interface in ReMashed and present the available learning goals in the system.

5 Conclusions and Future Research

This article presented the ReMashed system, an MUPPLE with a recommender system for learners. The article presented related work in MUPPLE in section two. Further it presented the ReMashed system in section three and discusses its application for formal and informal learning settings by using different recommendation approaches (section four).

Based on formal or informal learning setting of learners recommendations have to be done rather differently. In case ReMashed is applied in formal learning settings the recommender system can take advantage of well structured formal relationships like predefined learning plans (curriculum) with locations, student/teacher profiles, and accreditation procedures to recommend learning resources to learners. Therefore, more top-down technologies like ontologies and adaptive sequencing are suitable to offer personalized recommendations.

In order to apply ReMashed for informal learning settings, we need to take into account a lack of structure and maintenance. Thus, to handle the dynamic and diffuse characteristic of informal learning more bottom-up technologies like latent semantic analysis or mining techniques like hierarchical clustering are needed. They are more appropriate for informal learning settings because they require nearly no maintenance and improve through the emerging behaviour of the community.

In the future we want to explore most suitable recommendations approaches for the use of MUPPLEs in formal and informal learning. Furthermore, we want to improve interoperability of ReMashed to other MUPPLEs. Therefore, ReMashed has to provide a widget interface to enable lifelong learners to integrate the recommendations from ReMashed into their MUPPLEs. Such a widget should provide recommendations and the possibility to rate content from the community to further personalize the needs of the learners.

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