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The Application of Pattern Repositories for Sharing PLE Practices in Networked Communities

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Abstract: Personal learning environments (PLEs) comprise a new kind of learning technology which aims at putting learners into centre stage, i.e. by empowering them to design and use environments for their learning needs and purposes. Setting a PLE approach into practice, however, is not trivial at all, as the prospective end-users have varying attitudes and experiences in using ICT in general and PLE software in particular. Here, practice sharing could be an enabler for increasing the usefulness and usability of PLE solutions. In this paper we examine the relevant issues of capturing and sharing ‘good practices’ of PLE-based, collaborative activities. By good practices we refer to learning experiences provided by learners for a networked community. Moreover, we introduce the concept of a pattern repository as a back-end service for PLEs which should, in the sense of community approaches like Last.fm, support PLE users in selecting and using learning tools for their activities. Finally, we present a prototype and argue for the advantages of such a practice sharing infrastructure with respect to community literature, experiences, and an evaluation study.

Keywords: Personal Learning Environments, Practice Sharing, Digital Repositories, Virtual Communities
Categories: H.3.5, H.3.7, J.4, L.3.6, L.6.1

1 Introduction

According to [Henri et al., 08], personal learning environments (PLEs) refer to a set of learning tools, services, and artefacts gathered from various contexts and to be used by the learner who designed the environment. However, user studies in the field of higher education and workplace learning [Nguyen-Ngoc & Law, 08; Kooken et al., 07] evidence that learners – and even teachers [Windschitl & Sahl, 02] – have varying attitudes towards and hand-on skills in using ICT for learning. On the one hand, they may be capable of adopting and utilising new tools for their needs easily. On the other hand, ICT may restrict them as they spend too much time on playing around, being unfocussed when using them, or even failing to achieve their goals due to frustration and distraction by trying to handle them [Windschitl & Sahl, 02]. Such negative user experience hinders learners from proceeding with their learning as they cannot adapt their environments according to their needs and goals.

As stated by [Van Harmelen, 08], personal learning environments aim at empowering learners to design (ICT-based) environments for their learning activities and acquire competences through using PLEs and not being frustrated by ICT usage. [Eckstein et al., 01] outline the necessity of capturing and sharing successful teaching practices, i.e. through pedagogical patterns, so that instructors can set didactical strategies and translate them into practice without going through the time-consuming process of consulting didactical experts. Similar findings on pedagogical patterns are reported for CSCL processes [Persico et al., 09] and learning efficiency [Kolfschoten et al., 10]. In accordance with these experiences, practice sharing seems to be a critical requirement for personal learning environment (PLE) settings, as it can ease ICT usage and reduce frustration from working with technology.

In this paper, we build upon the idea of utilising activity patterns for capturing and sharing learning experiences with PLE technology and examine how a pattern repository can be applied to enable good practice sharing of PLE-based activities in networked communities. The term 'good practices' refers to the fact that we focus on experiences provided by any kind of end-user and do not restrict to best practices approved by PLE experts. The rest of the paper is structured as follows. The upcoming section describes our approach including definitions, theoretical foundations, and related work relevant for sharing PLE practices. Then, section 3 sketches the concept of a pattern repository and reviews state-of-the-art technology. Section 4 describes a prototype of an infrastructure for sharing PLE practices. This implementation is evaluated and discussed with respect to an example and related work in section 5, before the paper is concluded.

2 Capturing and sharing good practices in PLE settings

As mentioned before, personal learning environment (PLE) approaches have a strong focus on enabling learners to utilise learning tools for specific purposes in a certain context [Henri et al., 08; Van Harmelen, 08; Wild, 09]. On a very general level, learners are involved in *activities* in which they connect to learner networks and collaborate with peers on shared artefacts [Wild, 09]. The application of PLE technology particularly focuses on the field of lifelong learning, e.g. for learning on job, further or higher education, learning for private interests, etc., and thus can be very broad. Moreover, working with PLEs requires competences beyond the professional ones, so-called *transcompetences*, which comprise hand-on skills for learning tools, self-regulated learning skills or social competences [Henri et al., 08; Wild et al., 09]. Based on our understanding, PLE-related competences are supposed to be latent components of lifelong learning activities, whereby we will not examine them although they could be subject to further research.

As a first step towards PLE practice sharing and regarding experiences from community approaches like Last.fm (http://www.last.fm) or Mendeley (http://www.mendeley.com), we propose ***capturing the interactions of learners*** with their environments, i.e. with the tools, shared artefacts, and peer actors. However, recordings of learner interactions may not be shared for two important reasons, namely trust and privacy considerations [Dwyer et al., 07].

Trust can be understood as "*the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party*" [Mayer et al., 95]. Thus, it is recommended to give the learners full control over their sensitive data. Sharing these recordings should be initiated or, at least, be permitted by the learner.

In addition, privacy is defined as "*the interest that individuals have in sustaining a 'personal space', free from interferences by other people and organizations*" [Clarke, 06]. Digital recordings of learner interactions are part of this personal space and should be secured to preserve the learners' privacy, which particularly is necessary for open(-content) systems [García-Barrios, 09]. Consequently, our approach for sharing good practices starts with capturing learner interactions and continues with ***distilling and abstracting them into an 'activity pattern'*** if the user considers the activity to be successful and helpful for others.

[Alexander et al., 77] state that a pattern "*describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice*". Similarly, activity patterns can be understood as "*archetypal and reusable recordings of design decisions taken by the users or developers who created a learning environment*" (adopted from [Alexander et al., 77]), i.e. a recording of an interaction sequence with (partially) removed entities.

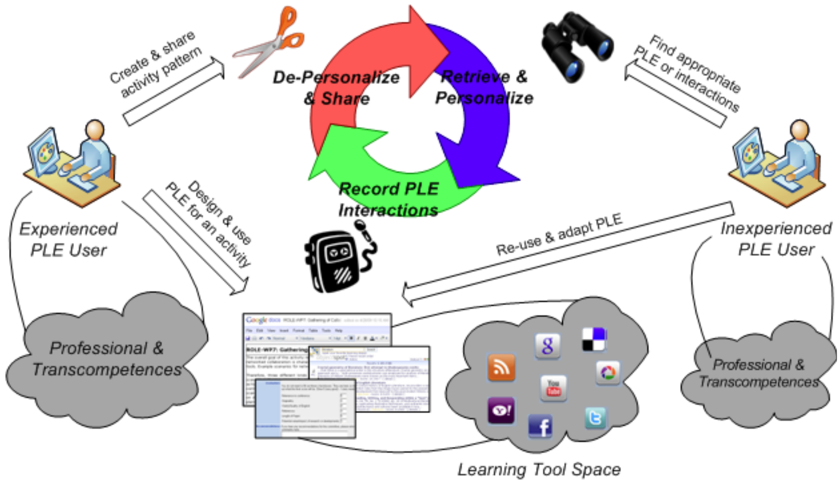

Figure 1: Good practice lifecycle in PLE settings

Activity patterns can reach from a single learner interaction, for example, selection or visual arrangement of a tool, up to a pre-configured PLE for a specific situation (an activity) which can even involve several actors, artefacts, and tools. Additionally, [Sobernig et al. 06] outline that "*design activity often is a construction process that aims at building constructs and conceptual models from [learning] experience*". Figure 1 visualises the ***process of good practices in PLE settings*** as a lifecycle. On the left side of the figure, users who are experts in their domain and have the required competences and skills utilise the tools available to achieve goals given by lifelong learning activities such as learning-on-the-job or further education.

The first important process in the good practice lifecycle deals with recording interactions of learners with their environments (the bottom arrowed arc in the cyclic graph in Figure 1). According to [Dillenbourg, 05], such interaction recordings contain rich information on e.g. the context of messages, knowledge sharing, sharing of construction of understanding, etc., thus being useful for other purposes like automated analysis or practice sharing. However, parts of the recordings might be sensitive or personal and, therefore, should be secured and controlled by the end-users. In the context of this paper, the process of anonymizing learner interactions is called 'de-personalization' which leads to digitalised learning experiences with removed or masqueraded parts, the activity patterns (the upper left arrowed arc in the cyclic graph in Figure 1). De-personalization extends the idea of anonymization in two ways. Firstly, it considers sensitive data collaboratively created by groups. Secondly, it includes the aspect that a pattern must be '(re-)personalizable' for others.

Consequently, the PLEs and interactions of experienced users are available to peers, either through own repositories, manual disclosure of the activity patterns, or automated approaches like generating recommendations from patterns (see also subsection 5.2). Now, it should be possible that other PLE users can find and re-use these patterns in their own way (the upper right arrowed arc in the cyclic graph in Figure 1). By re-using good practices of peers, the lifecycle starts with recording of user interactions again, leading to new patterns which can be slightly modified or completely different from the old one.

Activity patterns are situated and context-bound, each one standing for an activity experienced by one or more learners in a specific situation. Following the dimensions for building web-based personal learning environments [Palmér et al., 09], we identified these six dimensions for characterising patterns of PLE practices:

- **a)** ***Activity structure*:** It comprises the underlying pedagogical model used to describe the learning activities. Due to the broad range of possible application areas and the variety of possible end-users, this model should be generic and hide away the complexity of instructional design models [Wild, 09]. In practice, activities can be flat (a simple sequence of learner interactions), hierarchically structured (with activities containing other activities), or taking interaction flows into consideration.
- **b)** ***Interaction type***: It focuses on the kinds of interactions a learner has with her environment. Interactions can be pre-defined, i.e. restricted to the features of the environment and captured in the log files of the learning tools, or specified and 'implemented' by end-users, e.g. by selecting tools and describing their usage purpose with tags or other metadata.
- **c)** ***Tracked applications***: This dimension deals with types of applications which are considered for capturing learner interactions, thereby allowing pattern capturing to include desktop applications, web-based tools, or both.
- **d)** ***Privacy:*** It addresses privacy-related aspects of the interaction recordings which can be uncritical or contain private or sensitive data. How to preserve this data is addressed in the upcoming section.

e) ***Social:*** This dimension specifies if a pattern has been derived from an activity of a single user or a group. With a collection of many patterns, it would even be possible to analyse and evidence community behaviour in this data.

f) ***Context*:** It describes for which situations (e.g. lifelong learning activities) a pattern can be used. The context can be specified, for instance, by metadata (like the Contextualized Attention Metadata schema [Schmitz et al., 09]) or by information implicitly contained in a pattern (e.g. relations to other patterns or to activities, actors, artefacts, and tools).

Finally and in accordance with a study on ***PLE-related competences*** [Wild et al., 09], Figure 1 also indicates that practice sharing does not only focus on professional competences but also on transcompetences. The development of both competence types can be triggered by patterns, which is also evidenced by other pattern-based approaches [Eckstein et al., 01; Persico et al., 09; Kolfschoten et al., 10].

3 State-of-the-art overview of pattern repositories

Motivated by developments in the field of PLEs, distributed learning environments can follow different architectural styles (e.g. the five models described by [MacNeill & Kraan, 10]). However, none of these models takes into consideration practice sharing strategies. In the following subsection, we explain the concept of a pattern repository and its applicability for sharing good practices in PLE settings.

3.1 Basic idea and key features

In accordance with experiences from community approaches, like Last.fm, Wakoopa, or Mendeley, a ***pattern repository*** is a storage place which allows publishing and retrieving patterns. In the sense of a community platform, a pattern repository should be accessible by users via web interface and also by a PLE solution through an open API, implying that a pattern repository can be plugged into any PLE. Consequently, publishing PLE experiences (i.e. patterns) could be achieved manually through a web-based user interface or through PLE facilities but also automatically by the PLE exchanging data with the pattern repository in the background.

Highly important for practice sharing, the process of ***de-personalization*** aims at preserving sensitive data and learners' privacy. It can be supported by creating awareness about privacy-critical issues [García-Barrios, 09], providing facilities for manual editing interaction recordings, or by automated approaches. Automated de-personalization strategies are commonly known, for instance, in the form of anonymization and recommendation mining in social networks [Zhou et al., 08], as authentication, anonymity, and pseudonymity [Pfitzmann & Hansen, 08], or through social network analysis (SNA) approaches [Das et al., 09]. User-controlled de-personalization, on the other hand, is realised in certain web applications. Amongst others, the template sharing approach by Google Docs (http://docs.google.com) suggests users to edit a document manually before sharing it, while Yahoo Pipes (http://pipes.yahoo.com) includes a form-based mechanism to masquerade user data to be shared as a pipe.

Overall, patterns ***capturing PLE practices*** to be shared should include the aspects mentioned in the last section, namely (a) *a model to structure practices*, (b, c) the *types of interactions and applications* used, (d) *privacy considerations*, and (e, f) the *social form and context of an activity*.

From the perspective of pattern consumers, such a repository should allow ***retrieving and re-using patterns of PLE practices***. Referring to information retrieval strategies, pattern repositories can include facilities for actively browsing and searching the patterns. Furthermore, [Resnick & Varian, 97] state that ***recommendations*** are necessary if users have to make choices without sufficient personal experiences of alternatives, which is mostly the case for lifelong learners who try to utilise PLE technology for their very different learning contexts. Activity patterns distilled and abstracted from interaction recordings can be analysed according to a specific context which might be worth recommending to other learners.

A pattern repository could support users while working on a lifelong learning activity in two ways. On a macro level, it can provide a pre-configured PLE for a particular activity in a networked community before a learner starts to act. On a micro level and while being involved in an activity, it can support learners in designing and adapting their PLEs by recommending specific tools, certain documents, or relevant peer learners. However, mining and providing recommendation should neither threaten the users' ***privacy*** nor decrease the ***trustworthiness*** of the PLE infrastructure, as evidenced with a study on social networks [Dwyer et al., 07].

Besides retrieving patterns (through information push or pull mechanisms), such PLE practices also have to be instantiated before they can be used. ***Instantiation***, therefore, is the process of initialising and personalizing the environment which has been retrieved from or recommended through the repository. Depending on the de-personalization technique applied, this instantiation can be realised through facilities for specifying removed or masqueraded parts of the activity patterns.

3.2 Selected approaches from literature and practice

Referring to the concept of pattern repositories, related work can be found in many fields. In the ensuing text, we will highlight selected approaches in order to show how single aspects of pattern repository can be realised in practice.

First of all, ***personal and mash-up pages*** enable users to design web pages through inserting widgets and gadgets available. Personalisable portal sites like iGoogle (http://www.google.com/ig) or Netvibes (http://www.netvibes.com) capture the visual arrangement of widgets for each page. Others like Pageflakes (http://www.pageflakes.com) support sharing of user-created widgets ('flakes') and widget mash-up pages ('pagecasts'). Pageflakes even provides recommendations of flakes and pagecasts on the basis of tags and topicality. In the scope of technology-enhanced learning, PLE-like solutions comprise the Wookie server providing widgets for the learning management system Moodle or the social networking platform Elgg, the learning services for the LifeRay portal developed in the TENcompetence project (http://www.tencompetence.org), or the MUPPLE prototype [Wild, 09].

Secondly, with reference to ***capturing of learning experiences***, there exist various technical solutions for tracking and recording user interactions. For instance, iMacros (a Firefox add-on, cf. http://www.iopus.com/imacros/firefox/?ref=fxmoz) enables users to record and replay interactions with their browser, thus allowing them to automate specific work flows. Audioscrobbler, a service by the music platform Last.fm (http://www.audioscrobbler.net), tracks song listening habits of users and recommends new songs and song sequences based on statistical information about other users. Furthermore, Google Wave (http://wave.google.com) allows recording the collaboration on a shared artefact, while the CAMera tool [Schmitz et al., 09] aims at monitoring and reporting on learning behaviour in PLE settings by using the Contextualized Attention Metadata (CAM) schema.

Thirdly, ***publishing user experiences*** is realised in many approaches in the Web. Amongst others, Shareaholic (http://www.shareaholic.com) is a plug-in for nearly all browsers, thus allowing users to publish their URLs, manage them over several social sites and structure their online activities. Yahoo Design Pattern Library (http://developer.yahoo.com/ypatterns/) shares user interface patterns with the web design and development community. The patterns are differentiated according to categories devoted to interface design. They can be annotated and discussed within a community but not added by a community member. Last.fm provides a public API by which the Audioscrobbler application and users can submit information about their music listening habits. Similarly, Mendeley captures research activities (i.e. documents stored locally) on users' computers and submits them via a web service to an online repository. In both approaches it is possible to de-personalize the results of the activities just by moving from personal activities to community activities. Otherwise aspects of de-personalization can be identified by the template mechanisms in Google Docs or in the Learning Activity Management System (LAMS), a tool for designing, managing and delivering online collaborative activities. Hence, de-personalization has to be done manually by experts (e.g. the teaching community at http://e-teaching.org or the Technology-Supported Learning Database at http://aragorn.scca.ecu.edu.au/tsldb), by all kind of users (e.g. the MUPPLE prototype), or automatically by a software (e.g. the APOSDLE platform to support learning at workplace, cf. http://www.aposdle.tugraz.at).

Fourthly, pattern repositories also relate to ***information management in digital repositories***. Ideally, patterns can be managed in a structured way and enriched with metadata (like the CAM schema), as identified in approaches like the LAMS repository, APOSDLE, MUPPLE, etc. With reference to the ARIADNE repository [Najjar et al., 03], pattern repositories should store the patterns in a uniform format, thereby requiring the transformation of learner interaction recordings into this format.

Fifthly and with respect to ***information push mechanisms***, automated analysis techniques allow providing recommendations of learning experiences for specific situations, both realised in the APOSDLE prototype (recommendations of learning events, artefacts, and experts for the current working task). Furthermore, Wakoopa (http://wakoopa.com) tracks which applications are used on a computer, allows tagging and annotating the user interactions, and recommends tools according to the usage patterns. The PALADIN approach [Klamma et al., 06] applies social network analysis to detect disturbances in social networks, like spammers sending irrelevant messages to a community. Thus, PALADIN can be used to analyse the user interaction recordings stored on one repository and propose the ways of a community to cure. Moreover, [Klamma et al., 09] report on AERCS, a recommender system for scientific communities based on paper writing and co-author citation activities. Such a recommender system is particularly useful for inexperienced researchers to find appropriate collaborators and relevant events to attend.

Finally, ***information pull strategies*** deal with aspects of supporting learners to reuse activity patterns. Amongst others, APOSDLE and LAMS allows utilising captured learning events and LAMS templates for other topics, i.e., enabling the provision of good practices for completely different domains. Similarly, the MUPPLE prototype [Wild, 09] supports learners in creating activities from patterns, by manually specifying the parts which have been de-personalized by the pattern creator.

4 A practice sharing infrastructure for PLE settings

Although a lot of related work can be identified for parts of the good practice lifecycle (see Figure 1), we have not found a repository for publishing and retrieving patterns of PLE usage experiences. Therefore we propose an extended architecture for PLEs.

4.1 Architectural design and the first prototype

Instead of focussing on the architectural style of personal learning environments [MacNeill & Kraan, 10], Figure 2 shows how PLEs can be enabled for practice sharing through pattern repositories. These repositories are plugged into the PLEs in the back-end, no matter if the PLE software is a server-sided or client-sided solution. The left-hand side of Figure 2 shows the users working with their PLEs while on the right-hand side two example repositories are indicated. The upper (client-sided) PLE is connected to the pattern repository of a company while the (server-sided) PLE at the bottom is plugged to two repositories – the one of the company and another one of a scientific community. Using the web-based API of the pattern repository, a learner can authenticate at one repository, publish her experiences if willing to do so, retrieve and reuse pre-configured PLEs in the form of patterns, and receive recommendations.

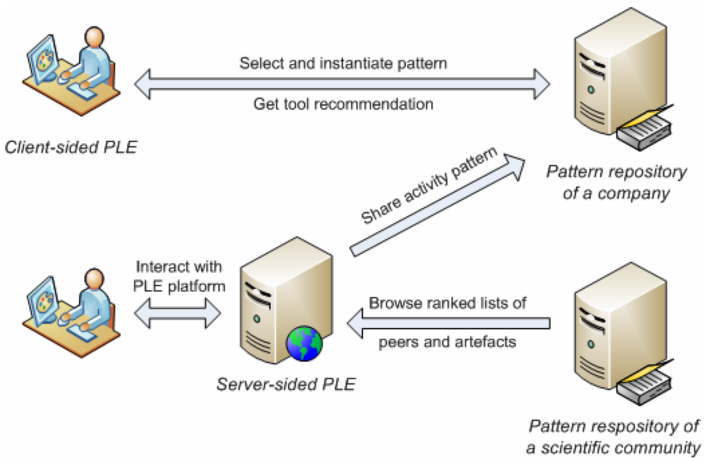

Figure 2: Proposed architecture of a PLE practice sharing infrastructure

As a proof-of-concept we have implemented the following two components:

1. The ***'Personal Activity Manager' (PAcMan)***: This Firefox add-on supports learners in structuring their learning context along with activities and in managing the URLs of the tools used. This client-sided variant of a PLE can be installed from http://addons.mozilla.org/en-US/firefox/addon/176479/.
2. ***PLEShare***: The prototype of a pattern repository is based on OpenACS (http://openacs.org) and the open source Wiki generator XoWiki (http://openacs.org/xowiki). An online demonstrator is available at http://teldev.wu-wien.ac.at/pleshare, and the sources of this prototype can be retrieved from Sourceforge (http://sourceforge.net/projects/rolewp7/).

Figure 3 shows the user interface of the client-sided PLE solution PAcMan with the activity navigation and management facilities being placed on the left-hand side. In the 'PAcMan' side-bar, learners can create and manage their activities, the online tools (URLs) used, and their user-given descriptions. Therefore they can create multiple contexts ('@Work', '@Home', 'Archive', etc.) and insert empty activities into these containers. While interacting with different web applications they can add URLs to these activities and tag these web resources.

The side-bar in Figure 3 shows all the activities being created in the context '@Work'. Furthermore, the activity 'ROLE WP7 Developments' is opened, which lists the web resources represented by the user-given tags. In the figure the interaction 'download the PAcMan add-on' is selected. The corresponding browser tab is in the front and shows the web site of the PAcMan add-on. In the current version of PAcMan we try to motivate users to enter meaningful purpose tags by displaying the phrase 'This resource helps me to ...' on the 'Add Resource' dialog and requesting users to enter this information.

Figure 3: Client-sided PLE prototype named Personal Activity Manager (PAcMan)

The bottom of the side-bar (see Figure 3) contains the facilities (buttons) to share patterns over the repositories which are currently plugged into PAcMan. Consequently users can select an activity and publish it to the repository (button ‘Share Activity’). Furthermore they can browse and search the patterns available in the repository (button ‘Pattern Store’). Concerning information push strategies the repository also provides recommendations of appropriate patterns if a user wants to start an activity. Moreover it is planned to recommend appropriate web resources, purpose tags, learning tools, and possible peers while being involved into an activity.

4.2 Technical details

Technically, our practice sharing infrastructure is based on two core technologies. On the one hand, PAcMan is realised as a Firefox add-on based on Mozilla’s XML User Interface Language (XUL, see http://developer.mozilla.org/en/xul) and core web technologies (HTML, JavaScript). Additionally we utilised the SQLite database integrated in the Firefox browser to store all the user-given input, i.e. the activity structure, all the activities’ URLs and tags, etc. Concerning the software architecture of the add-on we differentiated between two kinds of program sources: (a) JavaScript code for managing and processing the data behind PAcMan, and (b) XUL and JavaScript code for realising and adapting the browser’s user interface and providing the UI functionality required. We did not create different language resources, so the user interface of PAcMan is restricted to English only.

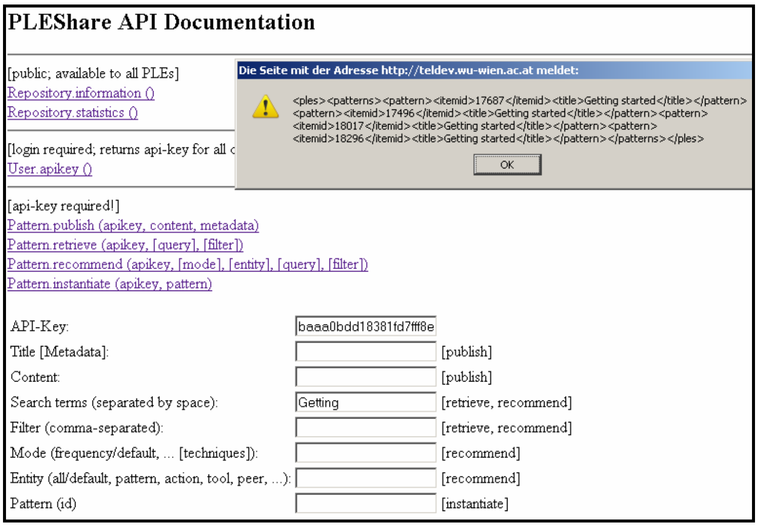

Figure 4: Web interface of the PLEShare component showing the test and documentation page of the REST-based API

On the other hand, PLEShare is implemented as an OpenACS component. It is derived from the XoWiki component which means that PLEShare inherits all features of XoWiki but is specialised in a certain way. Precisely we used all data management functionality of XoWiki, allowing us to store activity patterns as Wiki page and use the security policy, the admin interface, the versioning mechanism, and many other useful features of it. For PLEShare we created two new kinds of Wiki pages. A PLESharePage is capable of storing full activities from PAcMan or other kinds of PLEs. Here the permissions are tightly restricted to the activity owner, and the pages are not analysed at all. This kind of Wiki page is meant to be used for moving personal learning activities from a (client-sided) PLE solution to the repository. On the contrary, a PLESharePattern is supposed to be used for sharing PLE experiences and thus contains activity patterns which can be accessed by other users and are analysed e.g. to generate recommendations.

The PLEShare component can be accessed through two rather contrary interfaces. Firstly, the web interface allows users to navigate the pattern repository via browser. Currently the web interface is rather prototypical and is mainly used for administrating the repository, i.e. remove or correct existing patterns, analyse the data, manage the users and permissions, etc. Secondly, PLEShare provides a REST-based API which can be used by PLE solutions in order to integrate the pattern repository. Figure 4 shows our test and documentation page of this API which is accessible over the web interface. In the current version, this API (integrated into the PAcMan prototype) consists of the following classes and methods:

- *(1a)* *Repository.information()* returns all necessary information for accessing this repository;
- *(1b)* *Repository.statistics()* provides statistics on the patterns in the repository;
- *(2)* *User.apikey()* calculates and returns an API-key for all other operations;
- *(3a)* *Pattern.publish(apikey,content,metadata)* allows publishing one pattern;
- *(3b)* *Pattern.retrieve(apikey,query,filter)* returns the search results for querying patterns (result for test query ‘Getting’ displayed in Figure 4);
- *(3c)* *Pattern.recommend(apikey,mode,entity,query,filter)* provides recommendations of specific entities (patterns, peers, interactions, artefacts, tools, etc.);
- *(3d)* *Pattern.instantiate(apikey,pattern-id)* enables users to reuse a pattern.

On the technical level, the PLE has to realise the facilities for using the pattern repository API. In our client-sided PLE solution PAcMan (see Figure 3) we provide a button ‘Log In’ for authenticating at the repository which opens a session to the OpenACS server hosting the PLEShare component. On logging in users can publish and retrieve activities as explained in the last subsection (buttons ‘Pattern Store’ and ‘Share Activity’). In the current version of PLEShare we have implemented an item-based recommender system which generates recommendations for activity patterns through a trivial top-n algorithm [Deshpande & Karypis, 04]. This strategy, however, is not sufficient, which will be explained in the upcoming section.

5 First evaluation and discussions

In order to evaluate our practice sharing infrastructure, we have conducted two case studies and discuss further aspects of sharing PLE-based, collaborative experiences.

5.1 Analysis of PLE-based collaborative activities

In a first case study we used our PLE prototype and the pattern repository to capture four activities which involved the authors of this paper as well as three other actors. Figure 5 gives an overview of these activities. The learner who serves as the starting point of this study is located in the centre. The upper left corner shows a supervising activity in which a student attempts to complete a master thesis. An interesting aspect of our bottom-up interaction capturing process is that the actors having different roles perceive and enter other kinds of interactions. While the supervisor included all possible interactions, the student did not mention the communication taking place but rather focused on the topic of the master thesis and relevant literature.

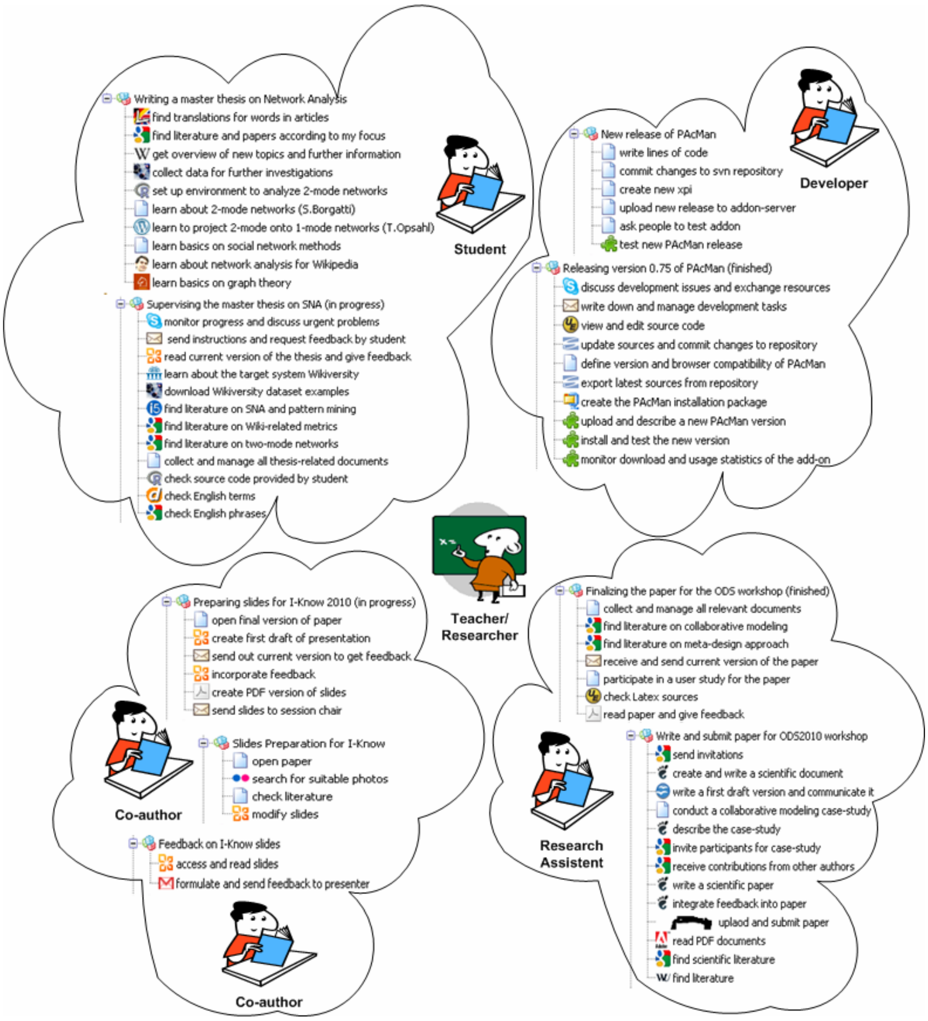

Figure 5: Four real-world activities involving six actors and their interactions with the learning environment

On the upper right corner, the interactions of a software release are subsumed under an activity. On the bottom of Figure 5 two more activities are visualised, namely the preparation of the slides for a conference presentation (left) and the finalisation of a workshop paper (right). The slides preparation activity involved three actors with two different roles. One learner (the presenter) was responsible for creating the first draft of the slides and for sharing them with two co-authors. Co-authors either gave textual feedback per email or included additional materials to the document.

Overall, this first study shows how we captured the learner interactions and demonstrates the diversity of these activities. Such activities can comprise the interaction patterns of a single user or a group. Depending on the learners' roles, a pattern focuses on specific aspects of an activity, for instance, gathering of relevant literature (master student) or discussion and delegation of issues (thesis supervisor). It is also observable that shared artefacts (i.e. identical URLs) in the patterns serve as synchronisation points within an activity. However, without explicitly assigning the collaborators it is not possible to fully reconstruct the activity and its interaction flow, as arbitrary users might use the same URLs (e.g. Wikipedia articles) within completely different activities. We call such relations 'weak ties' between users, while we consider collaborating actors as 'strong ties'.

Due to all these observations, we think that PLE-based networked collaboration is typical for so-called Communities-of-Practice (CoPs) (i.e. a group of people who share a concern or a passion and who interact regularly to learn how to improve [Wenger, 98]) which we understand as a community of learners producing similar activity patterns. Therefore we assume that it is possible to apply data mining and network analysis techniques to extract and utilise useful semantics (cf. the semantic lifecycle model given in [Mödritscher, 09]). An obvious application would be a SNA-like approach to connect learners over activities or even through interactions (strong ties). Additionally, weak ties could be of interest for bringing together the learners applying similar practices. Mostly relevant for PLEs, the exploitation of semantics should support end-users (the learners!) within their activities and in using ICT. Here, we foster the idea of providing PLE recommendations, as explained with a follow-up study in the upcoming subsection.

5.2 Generation of activity-aware recommendations

Presumably a repository full of user-given activity patterns can provide the opportunity to extract semantic information for supporting learners, for instance, through recommendations (see also subsection 3.1). As we base our whole practice sharing approach (including the aspect of generating recommendations) on the concept of our activity model, we call it an 'activity-aware recommender system'.

We conducted a follow-up study in which we tried to capture similar patterns. Similarity hereby refers to the fact that the actors are in the same situation and try to achieve the same goals. Therefore, eight researchers from the field of technology-enhanced learning and information systems were asked to design two typical activities: (1) one on searching literature relevant for a contribution to be submitted to their favourite conference, and (2) one describing all steps necessary to plan the participation in this conference. After the users submitted their experiences on these research activities, we analysed the data through quantitative and qualitative methods.

On the one hand, we ran a trivial top-n algorithm to determine the usage frequency of pattern titles, resource (purpose) tags, and URLs. Table 1 summarises these numbers in short, whereby first column stands for the number of the items per PLE-related entity (users, contexts, pattern titles, resource/purpose tags, and URLs). The second column denotes how many items occurred, while the third column counts the number of identical and the fourth column the number of similar items. Similarity was determined through a qualitative analysis manually and according to different categories (high-level topics, top-level domains).

PLE entity	**No. items**	**No. identical items**	**No. similar items**
Users	8	0	0
Contexts	8	8	8
Pattern titles	17	0	10 (topics)
Resource tags	99	13	53 (topics)
URLs	99	0	33 (domains)

Table 1: Number of items of each PLE-related entity

The first row, the entity ‘Users’, is given due to our test users, having no identical or similar ‘items’ – each of them is unique. The second row (‘Contexts’) also results from the study setup, as users were asked to create one context with a certain name. Addressing the ‘pattern titles’ (third row) it can be observed that each user published two patterns, as instructed in the study. Nevertheless one user split up the travel planning activity into flights and hotels, which was not explicitly forbidden. The fourth row, ‘Resource tags’, indicates that 13 of the 99 items occurred more than once (5 twice and 1 three times).

Analysing the resource tags closer, we identified five high-level topics (location, flights, hotels, conference websites, and a research topic) to which 53 resource items can be assigned. This kind of PLE entity evidences that natural language processing (NLP) techniques are necessary to cluster the tags (user-given natural language) into adequate categories (e.g. high-level topics). Finally, the fifth row shows that 99 URLs were used in the activities of the test users, whereby none of them occurred more than once. Analysing the URLs according to the top-level domains, we could assign 33 of them to 9 different tools, e.g. Google Scholar (9), ACM (5), Google Maps (4), Holidaycheck.com (4), etc. At this level, clustering could lead to recommendations on tool level, i.e. suggesting Google Scholar for finding literature.

The evaluation study showed that the number of interactions (resource tags) and URLs grows faster than the number of activities due to the semantic structure behind PAcMan (activities contain resources and URLs). This set of user data also indicates that it makes sense to cluster certain attributes of the entities, for instance, according to top-level domain names or high-level topics. Thus, clustering or other similarity techniques for user-given input (i.e. resource tags, activity titles, contexts, etc.) are useful to increase the quality of recommendations and their ranking. Figure 6 shows that the distribution of URLs is flat while the action tags already follow a very weak power law distribution. Clustering items according to topics or top-level domains (similar actions and URLs) lead to more significant power law distributions, even for this small set of user data. We then can use the semantics hidden in the data e.g. to recommend the most frequent items identified within the same or similar activities.

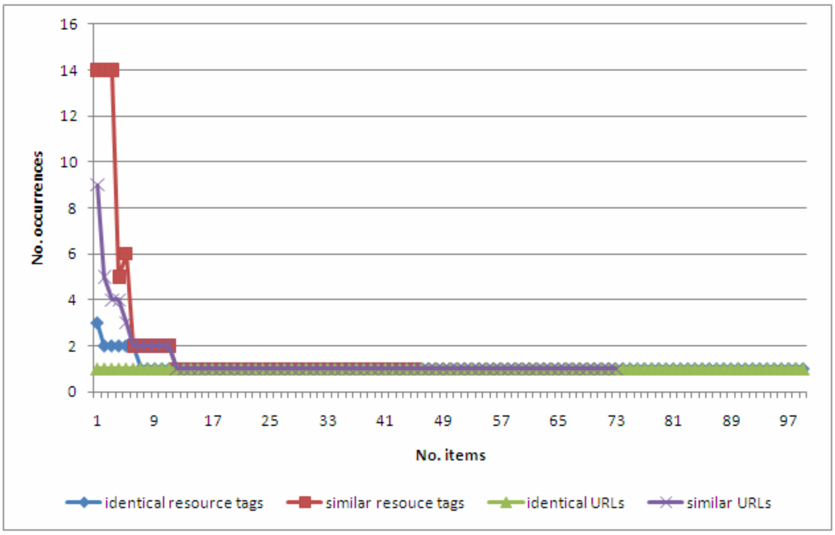

Figure 6: Distribution of resource tag and URL occurrences (identical, similar)

So far we have showed what can be recommended in a certain situation, i.e. within the same or a similar activity. The small amount of real-world data captured in this study is relatively uncritical, as a PLE recommender strategy aims at providing not the global but the local top-n items, i.e. the most appropriate recommendations for a specific situation. Thus, the algorithm has to work for such small data-sets, as PLEs comprise situated, highly specialised solutions for a few people and this will be the average amount of data to be expected for a CoP. However, the main claim of our approach deals with the question how to identify similar activities from a repository which potentially can contain good PLE practices of any possible kind (see the examples given in subsection 5.1).

Therefore, future work on our activity-aware recommender will address an approach to determine the similarity between activities on the basis of the learner interaction recordings and further meta-data. Moreover, user-designed PLEs also require strategies to overcome typical shortcomings of user-given content, like considering synonyms or grammatical variations on mining resource tags or pattern titles. Hereby, NLP techniques – ranging from stemming, stop words removal or part-of-speech tagging to high-level concepts such as latent semantic analysis – can be applied to cope with these problematic issues. Finally, also the evaluation of activity-aware recommendations is work in progress and might also have an effect on the recommendation mining algorithm, as a bottom-up approach like activity pattern sharing has to consider explicit user feedback, i.e. if users like or dislike the recommendations provided by the pattern repository.

5.3 Discussion of further issues of pattern-based practice sharing

These two studies show how PLE-based, collaborative activities can be characterised and how the interaction data captured can be exploited for supporting learners in using PLE technologies. In the first step we consider practice sharing and particularly recommendations to be the most relevant concepts for empowering learners to 'survive' in PLE settings, i.e. by sharing and finding good practices of PLE experiences through our pattern repository. Concerning recommendations, the last subsection evidenced that the patterns shared can be exploited e.g. in the way that the most frequently used entities (patterns, peer actors, tools, resource tags, and resource URLs) should be suggested to learners while the other items could be offered occasionally (as seen on the Facebook platform).

Next to these first findings, we also face open issues regarding our PLE practice sharing approach. The most important one deals with pattern usage which would require long-term experiences on our pattern repository. As we do not have empirical data for a longer period of time, we consider pattern usage as future work. In particular, we aim at examining the usefulness of pattern-based practice sharing as well as competence development through analysing the usage data.

Another unsolved problem is the one on privacy. As our practice sharing approach builds upon user data stored on a repository, users have to agree on sharing interaction recordings. The advantage we have is the fact that users explicitly share their data, i.e. by pressing the share-button, while server-based PLE solutions often collect this kind of data implicitly (e.g. Google or Facebook). With respect to related work from other EU projects (e.g. [García-Barrios, 09], it would be also good to support a more flexible privacy management – e.g. through the concept of adaptable privacy statements – and to create awareness for this problem – e.g. by visualising the effects of single statements on the user-data and the benefits for PLEs and the tools.

Finally, we have to state that our approach towards PLE practice sharing requires an incentive system to motivate users to share their experiences. Particularly, it is necessary to involve the active, high-skilled knowledge workers and domain experts to share activity patterns, as these practices can be valuable for learners who are inexperienced with PLEs or new in a domain or job position. Providing such valuable experiences would be a strong enabler for the usage of a PLE and the pattern repository. The main challenge, however, is to motivate successful PLE users, which we will try to address with a higher visibility within a potentially larger community e.g. through a loose integration of the pattern repository into Facebook ('User X shared an activity pattern on topic Y').

6 Conclusions and future work

In this paper we have argued for the need to support learners in using PLEs and have introduced the practice sharing lifecycle for this purpose. As a technical solution to sharing good PLE practices we build upon the idea of pattern repositories which we have implemented as back-end service for our own (client-sided) PLE solution. The first benefit of this solution approach is obvious – the web-based service (RESTful API) can be easily integrated in PLE prototypes with different architectural styles.

Moreover, this 'hidden' service enables users to share experiences of PLE-based, collaborative activities with colleagues in a similar way

Due to the early development stage of PAcMan/PLEShare, we have conducted only two small studies – one to demonstrate the diversity and characteristics of PLE activities, and one to show how to generate recommendations from the patterns. Experiences from literature and practice indicate the usefulness of practice sharing through pattern repositories. For instance, [Eckstein et al., 01] built their teaching practice sharing approach upon pedagogical patterns and showed that these patterns can increase teaching efficiency generally and particularly if no didactics experts are available. On the other hand, [Shaffer et al., 09] applied Epistemic Network Analysis (ENA) to measure the evolvement of learners in digital learning environments and identified positions of different competence types in epistemic frames (competence-maps), evidencing that learners start to imitate their mentors by generating similar competence-maps over the time. Our internal studies evidenced that some patterns were instantiated between one and four times for curiosity and for getting an idea how such an activity could look like.

From a more technological perspective, subsection 3.2 highlights that various aspects of the good practice lifecycle (cf. Figure 1) are supported by systems and frameworks already. Particularly community approaches like Last.fm (including the Audioscrobbler monitoring tool) or Mendeley are well accepted, providing recommendations in line with the authors' expectations, and can be taken as a technical roadmap for developing a PLE practice sharing API (see http://www.last.fm/api). Moreover, analysis and mining approaches like PALADIN or AERCS give good insights how to infer recommendations from patterns, while other repository solutions, like LAMS or ARIADNE, lead to key features of a pattern repository for good PLE practices.

The patterns provided by experienced PLE users for a community can be understood as triggers for the development of professional competences and transcompetences [Wild et al., 09]. Other approaches in literature and practice indicate that practice sharing is necessary, especially under the premise of facing a broad range of possible end-users reaching from tech-savvy PLE experts to inexperienced computer users. To evidence the usefulness of our practice sharing approach, it is necessary to provide usable PLE software and to evaluate pattern repositories on the basis of real-world data and over a long period of time. As many PLE prototypes are under development and in a rather immature stage, an evaluation of pattern usage will be the next step of our research.

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References

[Alexander et al., 77] Alexander, C., Ishikawa, S., Silverstein, M.: A pattern language: Towns, building, construction, Oxford University Press, Oxford, 1977.

[Clarke, 06] Clarke, R.: What's Privacy? Proc. of the Workshop at the Australian Law Reform Commission, 2006, http://www.rogerclarke.com/DV/Privacy.html (2010-03-30).

[Das et al., 09] Das, S., Egecioglu, Ö., El Abbadi, A.: Anonymizing Edge-Weighted Social Network Graphs, UCSB Computer Science Technical Report 2009-03, 2009.

[Deshpande & Karypis, 04] Deshpande, M., Karypis, G.: Item-based top-n recommendation algorithms, ACM Transactions on Information Systems 22, 2004, pp. 143-177.

[Dillenbourg, 05] Dillenbourg, P.: Designing Biases That Augment Socio-Cognitive Interactions, In R. Bromme, F.W. Hesse and H. Spada (Eds.): Barriers and Biases in Computer-Mediated Knowledge Communication, Springer, New York, 2005, pp. 243-264.

[Dwyer et al., 07] Dwyer, C., Hiltz, S.R., Passerini, K.: Trust and privacy concern within social networking sites: A comparison of Facebook and MySpace, Proc. of Americas Conference on Information Systems, Keystone, 2007.

[Eckstein et al., 01] Eckstein, J., Manns, M.L., Voelter, M.: Pedagogical Patterns: Capturing Best Practices in Teaching Object Technology, Software Focus 2(1), Wiley, 2001.

[García-Barrios, 09] García-Barrios, V.M.: User-centric Privacy Framework: Integrating Legal, Technological and Human Aspects into User-Adapting Systems, Proc. of the IEEE Intern. Conference on Information Privacy, Security, Risk and Trust (PASSAT), Vancouver, 2009.

[Henri et al., 08] Henri, F., Charlier, B., Limpens, F.: Understanding PLE as an Essential Component of the Learning Process. Proc. of the World Conference on Educational Multimedia, Hypermedia and Telecommunications (ED-Media), Vienna, 2008, pp. 3766-3770.

[Klamma et al., 06] Klamma, R., Spaniol, M., Denev, D.: PALADIN: A Pattern Based Approach to Knowledge Discovery in Digital Social Networks, Proc. of the International Conference on Knowledge Management (I-Know), Graz, 2006, pp. 457-464.

[Klamma et al., 09] Klamma, R., Cuong, P.M., Cao, Y.: You Never Walk Alone: Recommending Academic Events Based on Social Network Analysis, Proc. of the International Conference on Complex Science (Complex), Shanghai, 2009, pp. 657-670.

[Kolfschoten et al., 10] Kolfschoten, G., Lukosch, S., Verbraeck, A., Valentin, E., de Vreede, G.-J.: Cognitive learning efficiency through the use of design patterns in teaching, Computers and Education 54, 2010, pp. 652-660.

[Kooken et al., 07] Kooken J., Ley T., De Hoog R.: How Do People Learn at the Workplace? Investigating Four Workplace Learning Assumptions, In E. Duval, R. Klamma and M. Wolpers (Eds.): Creating New Learning Experiences on a Global Scale, Springer, 2007, pp. 158-171.

[MacNeill & Kraan, 10] MacNeill, S., Kraan, W.: Distributed learning environments: A brief paper, JISC Centre For Educational Technology and Interoperability Standards (CETIS), 2010, http://wiki.cetis.ac.uk/images/6/6c/Distributed_Learning.pdf (2010-03-30).

[Mayer et al., 95] Mayer, R.C., Davis, J.H., Schoorman, F.D.: An Integrative Model of Organizational Trust, The Academy of Management Review 20(3), 1995, pp. 709-734.

[Mödritscher, 09] Mödritscher, F.: Semantic lifecycles: modelling, application, authoring, mining, and evaluation of meaningful data, International Journal of Knowledge and Web Intelligence 1(1/2), 2009, pp. 110-124.

[Najjar et al., 03] Najjar, J., Duval, E., Ternier, S., Neven, F.: Towards interoperable learning object repositories: the Ariadne experience, Proc. of the IADIS International Conference WWW/Internet, Algarve, 2003, pp. 219-226.

[Nguyen-Ngoc & Law, 08] Nguyen-Ngoc, A.V., Law, E.L.: Perceived Usability of Social Software Enabling Self-Directed Learning, Proc. of the World Conference on Educational Multimedia, Hypermedia and Telecommunications, Toronto, 2008, pp. 1449-1458.

[Palmér et al, 09] Palmér, M., Sire, S., Bogdanov, E., Gillet, D., Wild, F.: Mapping Web Personal Learning Environments, Proc. of MUPPLE Workshop at the European Conference on Technology Enhanced Learning (EC-TEL), Nice, 2009, pp. 31-46.

[Persico et al., 09] Persico, D., Pozzi, F., Sarti, L.: Design patterns for monitoring and evaluating CSCL processes, Computers in Human Behavior 25, 2009, pp. 1021-27.

[Pfitzmann & Hansen, 08] Pfitzmann, A., Hansen, M.: Anonymity, Unlinkability, Undetectability, Unobservability, Pseudonymity, and Identity Management: a consolidated proposal for terminology. Technical report, 2008, http://dud.inf.tu-dresden.de/literatur/Anon_Terminology_v0.31.pdf (2010-03-30).

[Resnick & Varian, 97] Resnick, P., Varian, H.R.: Recommender systems, Communications of the ACM 40(3), 1997, pp. 56-58.

[Schmitz et al., 09] Schmitz, H.-C., Scheffel, M., Friedrich, M., Jahn, M., Niemann, K., Wolpers, M.: CAMera for PLE, Proc. of the European Conference on Technology Enhanced Learning (EC-TEL), Nice, 2009, pp. 507-520.

[Shaffer et al., 09] Shaffer, D.W., Hatfield, D., Svarovsky, G.N., Nash, P., Nulty, A., Bagley, E., Frank, K., Rupp, A.A., Mislevy, R.: Epistemic network analysis: A prototype for 21st century assessment of learning, Intern. Journal of Learning and Media 1(2), 2009, pp. 33-53.

[Sobernig et al. 06] Sobernig, S., Danielewska-Tulecka, A., Wild, F., Kusiak, J.: Interoperability and Patterns in Technology-Enhanced Learning. Polish Information Processing Society (PTI), Szczyrk, 2006.

[Van Harmelen, 08] Van Harmelen, M.: Design trajectories: four experiments in PLE implementation, Interactive Learning Environments 16(1), 2008, pp. 35-46.

[Wenger, 98] Wenger, E.: Communities of Practice: Learning, Meaning, and Identity, Cambridge University Press, Cambridge, 1998.

[Wild, 09] Wild, F. (Ed.): Mash-Up Personal Learning Environments. iCamp Deliverable D3.4, 2009, http://www.icamp.eu/wp-content/uploads/2009/01/d34_icamp_final.pdf (2010-03-30).

[Wild et al., 09] Wild, J., Wild, F., Kalz, M., Specht, M., Hofer, M.: The MUPPLE competence continuum. Proc. of MUPPLE Workshop at the European Conference on Technology Enhanced Learning (EC-TEL), Nice, 2009, pp. 80-88.

[Windschitl & Sahl, 02] Windschitl, M., Sahl, K.: Tracing teachers' use of technology in a laptop computer school: The interplay of teacher beliefs, social dynamics, and institutional culture, American Educational Research Journal 39(1), 2002, pp. 165-205.

[Zhou et al., 08] Zhou, B., Pei, J., Luk, W.: A brief survey on anonymization techniques for privacy preserving publishing of social network data, ACM SIGKDD Explorations Newsletter 10(2), 2008, pp. 12-22.