Utilising Pattern Repositories for Capturing and 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 proposed 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 applying learning tools for their activities. Finally, we present a preliminary prototype and argue for the advantages of such a practice sharing infrastructure with respect to community literature, experiences, and an internal evaluation study.

Keywords: Personal Learning Environments, Practice Sharing, Digital Repositories, Virtual Communities
Categories: H3.5, H3.7, J.4, L3.6, L6.1

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 the PLE 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 proposes an infrastructure for sharing PLE practices and describes a first prototype. This implementation is discussed with respect to an example and related work in section 5, before the paper is concluded and the next steps are indicated.

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 so-called 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 the 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 should 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 this 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 systems [García-Barrios, 09]. Thus, our approach for sharing good practices starts with capturing learner interactions and continues with **distilling and abstracting them into a so-called '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.

Activity patterns can reach from a single learner interaction, e.g. the selection or visual arrangement of a tool, up to a pre-configured PLE for a specific situation (an activity) which even can involve several actors. 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*". Fig. 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 learning tools available to achieve their goals given by lifelong learning activities like learning-on-the-job or further education.

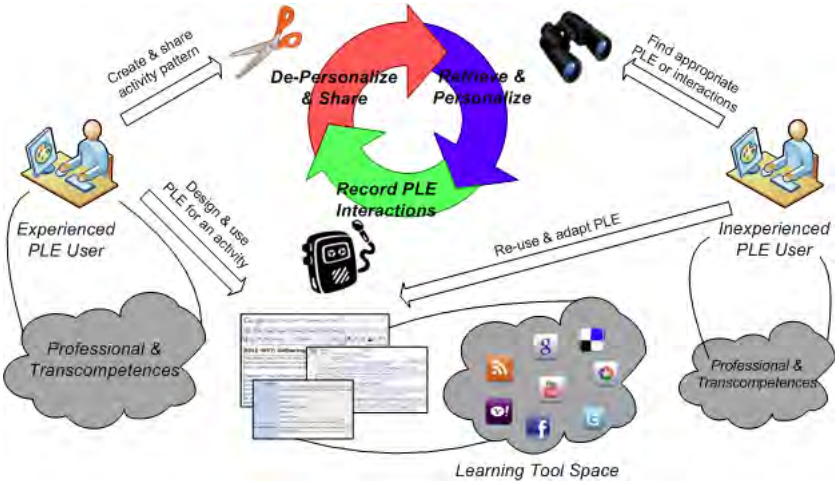

Figure 1: Good practice lifecycle in PLE settings

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 Fig. 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 Fig.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 PLE users are available to peers, either through own repositories, manual disclosure of the activity patterns, or automated approaches like recommendations mined from the patterns. 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 Fig. 1). By re-using good practices of peers, the lifecycle starts with the 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)** The **activity structure** 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 the complexity of instructional design models away [Wild, 09]. In practice, activities can be flat (a simple sequence of learner interactions), hierarchically structured (with activities containing other activities), or taking into considerations interaction flows.
- **b)** The **interaction type** 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 with tags or other metadata.
- **c)** The dimension '**tracked applications**' deals with the types of applications which are considered for capturing learner interactions. Thereby, pattern capturing could include desktop applications, web-based tools, or both.
- **d)** The **privacy dimension** 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)** The **social dimension** specifies if a pattern has been derived from an activity of a single user or a group. Having a collection of many patterns, it would be even possible to analyse and evidence community behaviour in this data.
- **f)** The **context dimension** describes for which situations, e.g. lifelong learning activities, a pattern can be used. The context can be specified e.g. 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], Fig. 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 personal learning environments, 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 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 the 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, e.g. 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 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, the 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 provides 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 trust and privacy concerns in 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 (re-)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 following, 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 online tools for each page. Others like Pageflakes (http://www.pageflakes.com) even 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 and referring 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. Another approach is Audioscrobbler, a service by the music platform Last.fm (http://www.audioscrobbler.net) which 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. 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. Thereby, 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 thus 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, provides tagging and annotation functionality as well as tool recommendations 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 the given learning events and LAMS templates for specific topics, i.e. enabling the transfer of good practices to 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 Fig. 1), we have not found a repository for publishing and retrieving patterns of PLE usage experiences. Therefore we propose an extended architecture for PLEs. Instead of focussing on the architectural style of personal learning environments [MacNeill & Kraan, 10], Fig. 2 shows how PLEs can be enabled for practice sharing through pattern repositories. These repositories can be plugged into the PLEs in the back-end, no matter if the learning environments are server-sided or client-sided solutions. Using the web-based API of the pattern repository, a learner can optionally 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.

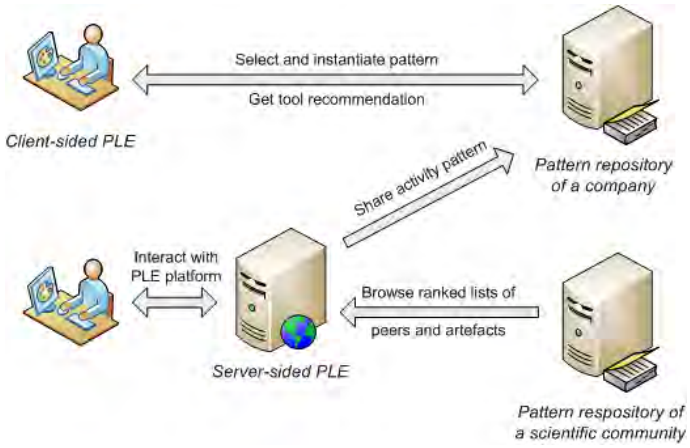

Figure 2: Proposed architecture of a PLE practice sharing infrastructure

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

As a first proof-of-concept we have implemented the following two components: (1) PAcMan, a Firefox extension supporting learners to structure their learning context

along with activities and to manage the URLs of the tools used. (2) PLEShare, a pattern repository based on OpenACS (http://openacs.org) and the Wiki generator XoWiki (http://openacs.org/xowiki). Fig. 3 shows the user interface of the client-sided PLE solution PAcMan with the navigation and management facilities being placed on the left-hand side. In the 'Activities' section, learners can create and manage their activities, the tools used, the relevant URLs, and user-given descriptions. The 'Share' section contains the pattern repositories which are currently plugged into PAcMan.

These repositories can be used to share or retrieve activity patterns or to receive recommendations, both achieved over a REST-based API. 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; *(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 client is responsible for providing the facilities for using this pattern repository API. In our client-sided PLE solution PAcMan (see Fig. 3) we provide a button 'Connect' for authenticating at the repository which opens a session to the OpenACS server hosting the PLEShare component. Now users can publish their activities ('Share' button) or browse and retrieve patterns ('Search' button, not shown in Fig. 3). In the current version of PLEShare we have implemented an item-based recommender system which generates recommendations through a trivial top-n algorithm. A preliminary study (8 users to publish two to three scientific activities) showed that the number of activities (17) grew linear and the number of interactions (resources and URLs; 92 vs. 99) even quadratic, as each activity contains on average 5.41 interactions. The number of URLs grew slightly faster, as we identified that 6 interaction names occurred twice or more often, while all URLs were unique but can be grouped according to 31 top-level domains. This analysis of the data gathered as well as further usage data (e.g. number of pattern instantiations) can be used for generating recommendations based on PLE-related models (e.g. clustering interactions by activities or URLs by top-level domains).

In practice, the pattern repository can be utilised in the backend of any PLE. A typical use case in the context of an academic institution is a collaborative paper writing activity in which a learner (co-author) is working with colleagues on a shared artefact e.g. by using Google Docs. Hereby the PLE captures all relevant interactions with the tools, peers, and artifacts, creating a recording of the activity. Good practice sharing starts right after this activity has been completed by the co-author. If the co-author is convinced that this PLE experience can be useful for others she can label it with a meaningful title (e.g. 'contribute to a paper for the I-Know conference') and publish it to the pattern repository. The repository may warn her if the recording contains sensitive data, i.e. the link to the joint paper. After de-personalizing this pattern, she can successfully publish it on the selected pattern repository.

A few days later another learner is invited to join another paper writing activity. As this learner has never contributed to a conference paper before, he looks up

relevant patterns on the repository and instantiates the one mentioned above. After opening the new activity in his PLE client, he has to specify the URL of the paper to write. Furthermore, he decides to remove the suggested email application and use his own one. Finally, he inserts the search engine Google Scholar as another tool for finding relevant literature. When entering his paper contribution into the shared Wiki page, the PLE client receives two recommendations of single learner interactions from the pattern repository, namely a dictionary service and a link to the glossary of his research colleagues. The learner decides to add the glossary to his environment in order to avoid terminological inconsistencies in his paper contribution. Having finished this activity, he also shares this (adapted) experience as a new pattern.

5 Experiences from related approaches and next steps

Due to the early development stage of PAcMan/PLEShare, we have collected only few data through internal studies. 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 study 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. Fig. 1) are supported by systems and frameworks already. Particularly community approaches like Last.fm (including the Audioscrobbler monitoring tool) 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.

In this paper we showed how the usage of PLE technology can be enhanced for real-world scenarios by adding a practice sharing infrastructure in the back-end. Thereby, we argued for capturing and sharing good practices in PLE-based, collaborative activities through so-called pattern repositories which can be plugged into the PLEs. 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 based on real-world data. As many PLE prototypes are under

development and in a rather immature stage, an evaluation of the PLE client PAcMan and the pattern repository solution PLEShare will be the next step of our research.

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