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Towards Personal infrastructure to manage long term open learner models

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ABSTRACT
Nowadays, the lifelong learning is a key issue in our life. Learners have their personal learning data scattered on different platforms and websites without any control on them and without any defined access duration. In this paper, we propose to explore the feasibility of Personal information manager systems in the Open Learner Model context that allows the control of personal learning data by learners themselves, the persistence, and the privacy. We propose to focus on a relevant technical infrastructure giving full personal control to users in order to manage Open Learner Models in lifelong and life wide perspectives. This work is dedicated for all lifelong learners without any specific IT competency to manage their own personal learning data in a lifelong perspective.

Keywords
Open Learner Models; Personal Cloud; Personal data; E-portfolio; Lifelong Learning.

1. INTRODUCTION
We all know that a person will have many different jobs during his/her life. Lifelong Learning is becoming a central asset, beginning during initial training at university, pursuing during the whole career with many different jobs. Learning is also life wide as we recognize that it occurs in multiple contexts: school, home, work, etc. Lifelong and Life wide Learning are seen as key elements for the prosperity, especially in a knowledge society. In this context, learners' personalization and social learning are essential concepts [1]. They encompass formal and informal learning in everyday situations, as well as lifelong goals management.

Learner Models are the representation of knowledge and learning process and they are also part of advanced learning environments. Open Learner Models (or OLMs) are Learner Models that allow the user (learner, teacher, peers and/or other stakeholders in the education process) to view the content in human-understandable form. They can also be Independent, or external to the system, giving the opportunity to the user to monitor, understand, and plan future learning throughout life. These may support reuse of parts of the Learner Models by different applications [2]. We consider that Independent Open Learner Models must be considered as long term models to encourage reflection, facilitate monitoring of learning and cooperation in social contexts.

According to [3], e-Portfolios are a form of the Open Learner Model which is the learner driven. A portfolio is a meaningful documentation of a learning path, either for assessment or for formative purposes [4]. E-Portfolios are one of those tools that have been appeared in education since Internet usage becomes more widespread. E-Portfolios represent an advantage over traditional portfolios in terms of storage, access, management, interactivity, real-time functionality, and presentation method. Compared with paper-based portfolios, they also have the added value in terms of keeping records, connecting ideas, relating information, and publication [5]. Research studies [6] have shown the e-portfolio influence and impact on learning performance. The e-Portfolios have a significant effect on education, they enable the aggregation and disaggregation of student data [7], which can then be used in program evaluation and accreditation [8].

Consider the following example; Alice is an engineer having completed twelve years of primary / high school in Australia, and four years at a school engineering in Belgium, and a final year project in Germany. She acquired Open Badges and certificates online. She developed assessed professional skills at work in different positions. She is recommended by many professionals on her LinkedIn profile. She also monitors her involvement in programming communities. She needs to access to all those models in her personal space, enabling her to collect data about any knowledge / skill and visualize progress.

This scenario illustrates a long term user model that aggregates data from many different sources, and is used in different contexts. Learning achievements and outcomes must be collected across different contexts: formal and informal learning (from institutional Learning Management Systems to personal quantified-self devices [9]), across different countries, and must remain available lifelong under control of the learner. The learner needs to monitor his Learner Models, modify them when relevant, store them for further use, publish them, and share them with peers.

These needs may be ensured by Personal Cloud features. The Personal Cloud describes a user-centric model of Cloud computing where an individual's personal content and services are available anytime and anywhere, from whatever device they choose to access it. And in emerging economies, where people often share mobile devices, each individual would be able to log into their own Cloud from the shared device. According to Frank Gillet, an analyst with Forrester Research, the Personal Cloud and how it will shift individual computing "from being device-centric to information-centric". He concludes that digital devices and services will combine to create the Personal Cloud, "an internal resource for organizing, preserving, sharing and orchestrating personal information and media."

New solutions like Personal Information Managers (PIMs) [10] are cloud-based data managers that provide data persistence and privacy-by-design [11] infrastructure. Cloud-based enables reliability of the storage, and access from everywhere. Security is ensured by design. PIMs are open source based and provide the ability to monitor networks exchanges, ensuring that third parties services meet their commitments.

In this paper, we propose to explore the feasibility of Personal information manager systems in the Open Learner Model context that allows the user control, persistence, enabling privacy as well as self-defined sharing. We propose to focus on a relevant technical infrastructure giving full personal control to users in order to manage Open Learner Models in a lifelong and life wide perspective.

The paper is organized as follows. Section 2 presents several existing approaches and projects for the OLM and personal data. In order to identify key criteria in data management aspects. Section 3 details our prototype and demonstrates the feasibility of personal information management for Open Learner Models, based on an e-Portfolio example. Section 4 concludes the paper and presents its perspectives in the lifelong learning field.

2. RELATED WORKS

In this section, we consider existing projects, concepts, and approaches related to the OLM context and the personal data. That is why we present the TenCompetence project, the Army Learning Concept, the MyData-Midata projects, and the Learner Models/ Badges approach.

The European Network for Lifelong Competence (TENCompetence) Development is a European project aiming at developing an integrated open source infrastructure that enables and fosters lifelong learning [12]. Users are able to integrate, manage and carry out their competence development activities and their own competences in interaction with other users, through a Personal Competence Manager [13]. However, this manager is not directly connected to any source, and as the system was not fully deployed nor long term access neither data disclosure are provided.

The Army Learning Concept (ALC) 2015 describes a learning model that leverages peer-based learning [3]. According to ALC 2015, the e-Portfolio is the central Learner Model that collects data from multiple sources and it is considered as an Independent Lifelong Learner Model. In this approach, learners owns data, however, the institution is considered as the steward of their OLMs, limiting the focus of the e-Portfolio to institutional aims, and not allowing users to claim their data.

The Mydata project in US (and another similar project named Midata in UK) works with businesses to give learners better access to their electronic personal learning data that companies hold about them. This is proposed in a broad context of data disclosure and openData. Those initiatives are steps in the right direction but neither giving access to the whole sets of data collected during learning nor providing specific services for managing those data. Note that these two projects are limited to specific countries.

The Open Badges is a concept proposed by the Mozilla foundation and is presented in [14] about an evidence-based source for Learner Models. The foundation proposes an infrastructure to create badges, to validate them through external (institutional) servers, to collect multiple user badges in a single backpack. Badges acquired may be published in social networking services like LinkedIn. However this backpack is not sufficient to manage badges according to personal goals.

These projects, concepts, and approaches enable us to define important criteria in the OLM context that allow the user control/persistence, and enable privacy as well as self-defined sharing:

- Data access: The solution must allow access to learners' data. The learner must be able to interact with data, to classify his Learning achievements and related outcomes, or to update some information.
- Data duration: Learners must be able to control data duration (long and short) according to lifelong goals. Nowadays, duration is defined by institutions according to their own requirements and ethics policies. Learning traces can only be stored for one year and used for predefined purposes. Student grades are generally stored during 5 years in French institutions. Learner himself may be interested in comparing current practices with his learning outcomes so long ago, or visualize long term trend indicators.
- Personal data storage: learners must have their personal data storage as a personal resource for organizing, preserving, sharing, and orchestrating personal learning data.
- Data transfer: learners must be able to download data from any platform, to upload and reuse them in their personal data storage. Two modes of transfer should be achieved: results (such as grades or diplomas must be provided by educational institutions) and learning traces collected along the learning process must be captured.

In the rest of the paper, the term “data management” refers to the data access, data duration, personal data storage, and data transfer.

Across the table 1, we found that no projects or approaches meet these criteria. That is why we have not been able to retain any existing approach and we need to propose a new solution covering all the criteria described above.

Table 1. Existing approaches related to the OLM context and the personal data

	Data access	**Data duration**	**Personal Data Storage**	**Data Transfer**
TenCompetence	Yes	Short	No	No
Army Learning Concept	Yes	Short	No	No
MyData – Midata	No	No	No	Yes
Open Badge	No	Long	No	Yes

To highlight all these ideas, we are going to detail in the next section our approach that meets all these requirements and provides innovative solutions in this domain.

3. A PROTOTYPE OF PERSONAL INFORMATION MANAGER FOR E-PORTFOLIO

In this section, we present a proof-of-concept prototype based on a Personal cloud infrastructure and standard interface implementation to collect data. We demonstrate how our solution provides the required data management.

We use the Cozy cloud framework[1] to implement the concept of Personal cloud. It provides a data oriented platform, with privacy and user control as key concepts. We choose this framework because it includes required components/functions: controller to manage applications, proxy to authenticate requests from users, and redirects them; and Data System, to store data and make sure applications only access the data they are allowed to.

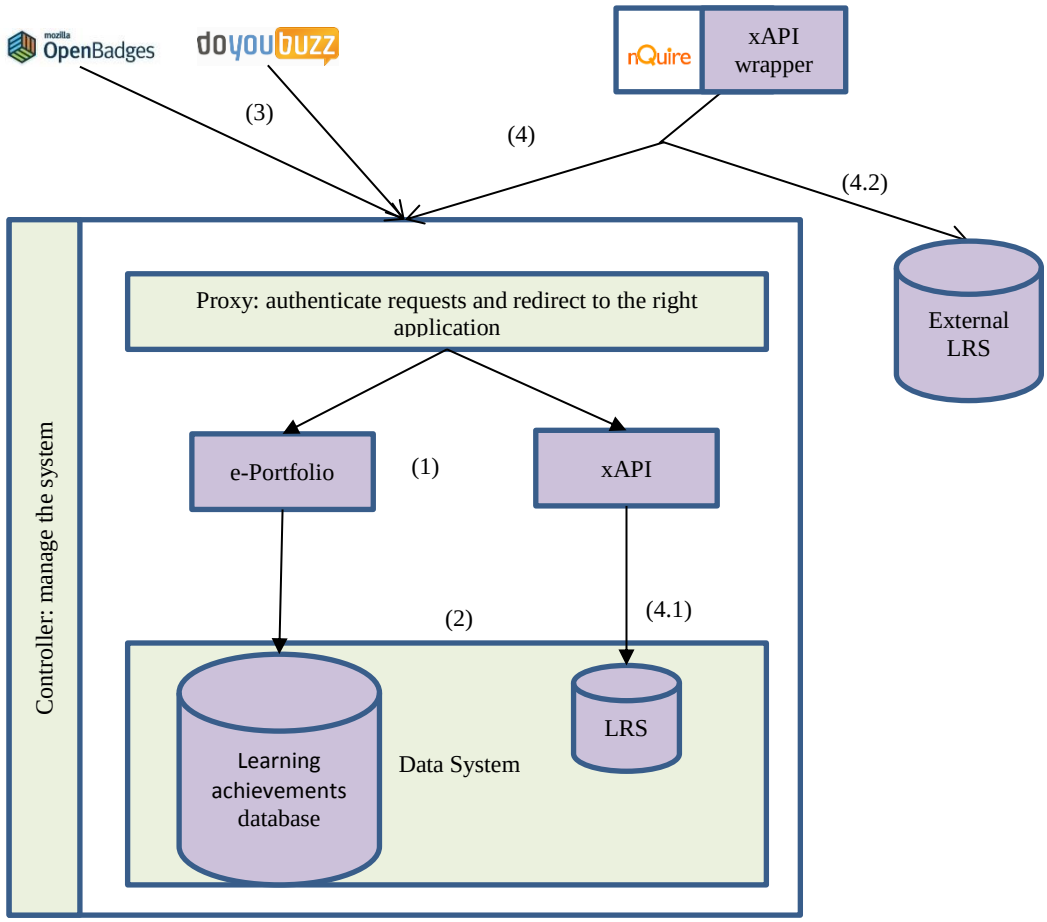

Figure 1. Prototype architecture

Figure 1 shows the prototype architecture[2]. Infrastructure components of the personal cloud are highlighted in green. Learning components (including services) are highlighted in purple. In our architecture, e-Portfolio (1) is seen as an example of the Learner Model. It enables data access according to lifelong personal goals. Implementing such Learner Model in a Personal Cloud provides personal data storage (2), enabling full data access to the learner and full duration control as well. Data are collected in two different ways: external learning achievements may be collected through a data transfer mechanism (3) from external servers, whether institutional or commercial, or learning traces through a learning streaming flow (4). The proxy mechanism (5) provides a basic mechanism to grant access selectively.

In this context, we developed two data transfer connectors. The first data transfer connector retrieve Open-Badges, where the user may synchronize her personal learning achievement database with existing backpack. As validation of badges is maintained by external (institutional) servers, the user is only able to classify which ones are relevant for what purpose in her e-Portfolio. Other digital diplomas can be retrieved in a similar way. The second data transfer connector retrieve commercial e-Portfolios, the commercial e-Portfolio service provides a specific API enabling download of existing learner certifications. This service can be extended in the case of LinkedIn.

Once the data transfer connectors are implemented, we need to aggregate data from various learning sources, this must be achieved through specific API, based on linked data to enable higher semantic information level, or data streams. Those data are collected in data stores, providing access to various services see [15] like reflection, visualization, adaptive learning…. New standards have emerged, called xAPI that provides data streams based on statements (ex "I did this") to depict activities, and on

[1] www.cozy.io

[2] Source code available at :
https://github.com/CPatchane/cozy-portfolio/
https://github.com/hazem92/Cozy-Learning-Record-Store

Learning Record Stores (LRS) to provide data access. Those standards are widely adopted in the open learning environments [16]. In our context, statements are duplicated in the learner personal cloud and the external LRS, enabling data collection for personal (4.1) and institutional (4.2) record storage at the same time. This gives the opportunity to fulfill institutional analytics needs, and also give direct access to the user. Our architecture also enables the exchange between personal and institutional records.

We developed a specific Learning Record Store compatible with cozy framework and based on the xAPI to enable data aggregation from various contexts. As it is embedded in cozy context, it ensures the user control, as well as the ability to fine grained control access to third party services and to other LRSs as well.

This prototype is able to store statements from various applications proposing a xAPI wrapper. We used some basic examples, and developed a specific wrapper we tested on nQuire, which is a personal inquiry learning system proposed by the Open University [17]. As a proof of concept, this wrapper sends activity statements to the user's personal LRS and in parallel to his institutional LRS.

Considering our introductory example, thanks to our architecture, Alice can aggregate learning data from multiple sources, she can have in her personal cloud her diplomas from the primary / high school in Australia, from the school engineering in Belgium, her certificate of training from Germany, and other online certifications (Open Badges, LinkedIn, DoYouBuzz…). She can store for her whole life these certifications independently from any institutions or commercial platforms. She can also monitor ongoing activities through xAPI collection, including informal learning. She can manipulate her portfolio as a completely Independent Open Learner Model.

4. DISCUSSION AND PERSPECTIVES

This study addresses the problem of the learner data management in lifelong learning. The main questions of the study are how to render learners to be masters of their learning achievements independently from any platforms and what is the suitable functional and technical infrastructure to achieve this goal. We investigate the problem from its theoretical background, and we consider existing approaches for the OLM context and the personal data in order to see if any existing approach can meet our requirements. As shown in the state of art, no one can fully respond to our needs in terms of the support of the learner control, the privacy and the lifelong storage of data.

To achieve this, we propose an architecture that is a Personal Information Manager System for e-Portfolio that provides lifelong data access and storage aggregated from different sources, including learning achievements and learning traces. This solution provides a self-learning trace storage that can be deployed in collaboration or in parallel with other tracing systems.

Our perspective is to add the "exchange" dimension to the proposed architecture. This dimension, as described in the Alice's scenario, is about exchanging her information with alumni association, initiating new collaboration based on her learning achievements and having feedback about her OLMs through interaction with her social network.

We are interested in the trust and scrutability dimensions. Trust is about supervising who use data and how they are used. Scrutability [18] is about understanding how the system arrived at the information the user sees. Both dimensions are ensured at the learner's community level through the open source implementation of our solution.

Another important point is the evaluation of learner's acceptability of our approach from the user-centric vision and the personal learning data vision. In our institution, learners are reluctant to use existing e-Portfolio platforms because initial investment is high and long term accessibility is unknown.

The question is to know if such independent e-Portfolio, with improved data collection and long term data duration may be more accepted by users and relevant for lifelong learner reflection than an e-Portfolio proposed by educational institutions.

We think that our proposed solution provides an open environment for innovation around lifelong and life wide learning. New services must be developed in order to test how the lifelong learners' data management can promote the learning-to-learn skills (learning reflectivity, facilitate planning, enhance user participation, and monitor learning). This evaluation must be conducted by the learner's community, the central actor and the final user, who must express their own needs in order to foster the feeling of community among all learners. Teachers and Institutions could be of course part of the evaluation, but would no longer be the leaders of learning services.

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