A Services-enabled Environment for Personalising Lifelong Learning Pathways

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Abstract. Assisting independent learners to access, compose and manage their learning pathway throughout their life in a range of institutional, informal and work-based settings is a challenging issue on the lifelong learning agenda. In this paper, we present a service-based architecture and an implementation that provides support in planning lifelong learning and creating personalised learning pathways. The architecture integrates several tools and web services, interacting with services provided by external organisations in order to create an environment that supports independent lifelong learners in identifying learning opportunities available through different learning providers at regional level. The resulting system offers functionalities for the creation of individualised learning pathways, and for the sharing of personal learning experiences with the regional community of independent lifelong learners. The system also offers recommended learning pathways through courses and learning opportunities in order to facilitate learners' progression into Higher Education and support career choices.

1 Introduction

Rapid changes in technology, workplace, communications and educational institutions have resulted in widespread awareness that education is not limited to childhood and adolescence, but it has become a lifelong activity. The Higher Education (HE) sector has recently undergone a series of changes, affecting its organisational structures, traditional practices as well as the perception of HE institutions and academics by the local community and the public in general [13].

Thus, the educational system is moving, as Parry states [15], 'from an early notion of access based on defined routes and discrete courses to one more centrally concerned with the "accessibility" of institutions and the suitability and flexibility of their curricula for a diverse student audience.' In this context, it is important to ensure

[1] The authors would like to acknowledge financial support from the UK Joint Information Systems Committee's (JISC) Distributed e-Learning Programme for the work conducted in the Lifelong Learning in London for *All* - L4*All* project (www.lkl.ac.uk/research/l4all/). They also wish to thank their collaborators: S. de Freitas and I. Harrison (Birkbeck College); M. Oliver and A. Mee (Institute of Education); J. Paschoud and S. McLeish (London School of Economics).

that learners are experiencing an appropriately increased learning challenge and autonomy as well as independence [13]. Making this happen in practice requires that learners become more aware of their own studying and thinking processes, and demands that tools and guidance are provided to support this process of planning a *lifelong learning pathway* through the various courses, levels and stages of an educational system.

Personal development planning [9] has been proposed as a means of encouraging students to reflect on their progress towards achieving specific goals, while the role of careers guidance in lifelong learning has been emphasised by the Organisation for Economic Co-operation and Development [14]. In this vein, the HE Funding Council for England, the Learning and Skills Council, and the UK Department for Education and Skills are currently exploring the scope for developing Lifelong Learning Networks (LLNs) in individual regions, i.e. networked organisations of groups of institutions, including HE institutions and Further Education colleges, that come together across a city, area or region to offer new progression pathways for learners. In an LLN, lifelong learning becomes a collaborative and community-based process, which calls for tools to support the autonomous and dynamic creation of lifelong learning communities and new distributed e-learning services.

These changes to the educational landscape, both nationally and internationally, require that technology is used effectively to assist lifelong learners to access, compose and manage their learning under varying circumstances and settings, such as institutional, informal and work-based. Thus,

- Models need to be developed and frameworks need to be extended that will allow local, regional, national and international systems to work together to provide coherent access to e-learning resources;
- Pilots need to be established that will evaluate the integrated use of e-learning systems, tools, repositories, and content by teachers and learners with respect to their effectiveness in supporting widening participation in HE and lifelong learning.

A number of attempts have been reported so far to create decentralised solutions where both resources and computation can be distributed [3], [4], [7], [12], [16]. Several consortia and initiatives around the world have been developed to support the development of new distributed e-learning services, such as the E-Learning Framework (www.elframework.org) promoted by JISC (UK) and DEST (AUS), the IMS Abstract Framework (www.imsglobal.org/af/), the Open Knowledge Initiative (www.okiproject.org), and the European Learning Grid Infrastructure Project (www.ELeGI.org).

This paper presents a service-based architecture that adopts the ELF specification. It integrates tools and web services, and interacts with services provided by external suppliers in order to create L4*All* – an environment that supports independent lifelong learners' progression into HE and career choices. Section 2 describes some of the main features of the L4*All* system, while Section 3 examines service orientation and its advantages. Section 4 provides an overview of our approach in developing L4*All* and the technologies involved. The paper ends with our concluding remarks.

2 Supporting the Independent Lifelong Learner in L4*All*

The LifeLong Learning in London for *All* (L4*All*) project has focussed upon supporting independent post-16 learners who traditionally have not participated in HE. The lack of information about learning opportunities and the perception that such learning pathways are 'not for me' have led to self-exclusion from such opportunities in the London region. L4*All* aims to provide lifelong learners in the London region with access to information and distributed resources that facilitate their progression from Further Education (FE) into HE. L4*All* allows career advisors, widening participation officers and learners to create and reflect on learning pathways offered in the London region.

Figure 1 illustrates the main interface of the L4*All* Trail Creator. This is the component of the system that supports learners in creating their learning trail or *timeline*. A timeline consists of several life episodes, and can be created by dragging and dropping lifelong learning activities from the My Courses and My Recommendations lists which have been previously identified through personalised searching or recommended through other services of the system. Learning and work related icons as well icons that represent a variety of life events, and even customised icons, can also be included in the timeline. Episodes can be annotated and the timeline created (an example is shown at the bottom of Figure 1) can provide a holistic view of an individual's lifelong learning pathway, giving details of particular life episodes in the Detail Window.

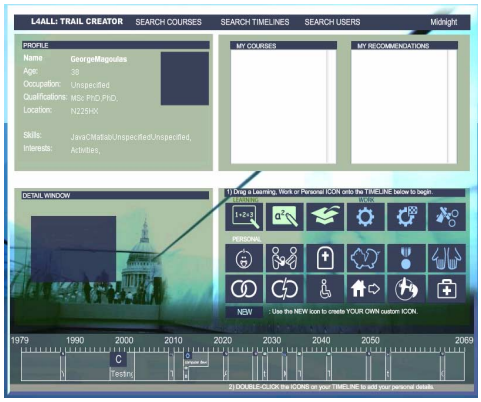

Figure 1. Screenshot of the main timeline creation interface.

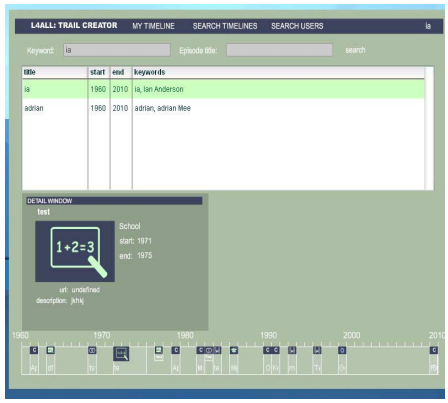

Figure 2. Searching timelines of others

As an aid to constructing their own learning pathways throughout their life, learners are able to search for timelines provided by career advisors and other learners. This gives learners a repertoire of learning possibilities that they may not have otherwise considered, allowing sharing of successful learning pathways and presenting successful learners as role models to inspire confidence and a sense of opportunity amongst those previously excluded. A personal space for lifelong learners such as this contrasts with many of the learning environments currently in use, which provide

learners with resources and learning management tools that relate to their study at a single institution. L4*All* offers learners a set of distinct features, such as learner control over learning pathways, reflection on where their learning is taking them, management of their profile, view of their learning pathway throughout life, a sense of community building, and information sharing with individuals and organisations.

3 Service Orientation and Personalisation

L4*All* adopts a design approach that is based on the JISC's ELF (www.elframework.org), which defines and provides technical standards for services so that these can be built individually as discrete units and then combined together into a larger system. The services map onto identifiable functions within teaching and learning. For example, searching courses or sequencing of learning activities can be defined as individual services within the framework, and can be used together (with other underlying services) to find learning opportunities that match learner preferences and plan personalised lifelong learning activities that help to achieve a particular goal. This focus on defining, constructing and combining small chunks rather than building a large monolithic system is known as a *service-oriented* approach.

Service orientation permits the development of modular and flexible personalised systems, where components can be added, removed or replaced more easily than in traditional models of adaptive hypermedia systems, and where new applications or systems can be composed from collections of available services [1]. Service-oriented approaches allow the integration of user models, adaptation techniques and web services and provide several benefits [11]: support for planning technical and interoperability specifications, and standards development; enabling alignment with business processes and supporting business models; offering flexibility in accommodating evolving organisational requirements; providing a flexible and modular technology base; making information sharing of applications simpler; and allowing co-operating organisations to deploy applications that meet their common needs. Service-oriented approaches also facilitate the integration of commercial, in-house and open source components and applications within organisations and federations by agreeing upon common service definitions, behaviours, data and user models, and protocols.

A service-based architecture may provide personalisation on the basis of well defined service behaviours and interfaces and allows various open specifications, open source toolkits and standards to be used in implementing the services. From the functional definition and scope of a specific service, an abstract model of behaviour and data can be developed which describes the expected behaviour of a realisation of this service and the data it handles or exchanges. Although service-oriented architectures can be realised in a number of other ways, the emergence of the Web Services approach based on protocols such as HTTP, XML, SOAP, UDDI and WSDL, allows services to be platform and language independent, and dynamically located and invoked.

The service-oriented approach models an application on the basis of services and processes that describe sequences of steps and the services and data involved in each step [2]. Personalisation in this context emerges through the aggregation of a set of services that implement a personalised functionality [4], [10], [17]. It can be materialised by creating, managing and storing user metadata, usage behaviours or relationships between user behaviours from a diverse set of existing applications using a user model service. This can be used for matching resources against user data, combining components (which will provide the necessary functionality) and assembling services from a set of components to tailor content, interface features, filtering and navigation support to the needs of a user. Attempts to further enhance this personalisation approach exploit advances in the infrastructure of the semantic web, which is expected to augment the current web with formalised knowledge and data that can be processed by computers [5]. In this context, a user model can be distributed and reflect features taken from several standards for user modelling and be supported by various web services [6], [7], [11].

4 L4*All* Architecture and Technologies

L4*All* consists of a set of components and services, and is consistent with the ELF. A sample of the services of the L4*All* system is shown in Table 1

Service	Functionality
Search learning opportunities	Performs search on courses.
Search among peers	Searches for people with similar preferences and characteristics
Recommendations	Provides a set of qualifications and experiences required to pursue a particular career goal (part of auto-mentoring).
Search learning pathways	Searches for timelines that match some criteria, e.g. keywords, experiences
User profile	Manages the user models
Timeline	Stores a timeline and its attributes for a particular user.
Episode	Manages the episodes of a timeline

Table 1. Sample of services used to accomplish tasks in L4*All*.

The L4*All* architecture comprises two parts: (a) the backend and (b) the user interface. To implement its functionalities, the backend interacts with three external services, wrapping them into a set of web services accessible through the user interface: DELTA (www.essex.ac.uk/chimera/delta/index.html) for searching over RDF metadata resources; ISIS (www.hull.ac.uk/esig/isis.html) for providing sequencing over a set of courses (in our context these correspond to lifelong learning activities and stages) according to a set of criteria that relate to user characteristics and preferences; and a third external service that retrieves search results from the

LearnDirect courses database (www.learndirect.co.uk). The backend also connects with RDF repositories for storing, retrieving and modifying metadata that describe users and learning courses/opportunities/activities.

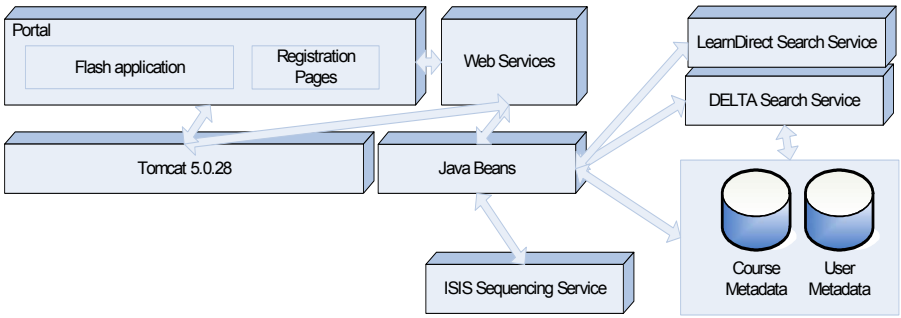

Figure 3. Main components of the L4*All* system architecture

Figure 3 illustrates the overall architecture and its major components. The *Web Services* component consists of the set of web services which we have developed in order to wrap the backend functionality into a set of services that can be called by the user interface. These web services are implemented as Java servlets over Apache Tomcat 5.0.28. They accept HTTP GET and POST requests from the user interface components and dispatch them to the appropriate Java Bean for processing. The results of processing are sent to the called service where they are formatted into XML and then passed back to the calling user interface component. The *Java Beans* are a set of Java classes providing the core backend functionality. This is where the three external services are connected with the system and where communication with the metadata repositories is handled, including all actions relating to storing, retrieving and modifying the course and user metadata.

A portal, developed using uPortal (www.uportal.org), serves as the platform for user-system interaction. A *Flash Application* and *Registration Pages* make up the user interface. From within the Flash application users are able to visually create and manage their timelines, search for courses according to various criteria and preferences, search for other users with similar goals, preferences and learning characteristics, search other learners' timelines and episodes, and receive recommendations about future learning choices based on their goals and preferences. The Flash application interacts with the Web Services for sending and retrieving information to the backend. The Registration Pages are where a user registers with the L4*All* system and provides personal information to it. They are implemented using HTML and JavaServer Pages for contacting the necessary service from the backend for the submission and update of the user metadata. Both the Flash application and the rest of the user interaction pages are embedded in the portal.

The *course* and the *user metadata* are encoded in RDF (www.w3.org/RDF/) using the Dublin Core (dublincore.org) and IMS (www.imsglobal.org) standards. These standards have been extended to include some additional properties for lifelong learners and learning pathways (see Figure 4 for a fragment of the learner schema). The course and user metadata are stored in a MySQL database using the Jena

framework (jena.sourceforge.org) as a wrapper over the database that provides mechanisms for storing, retrieving and querying the RDF metadata.

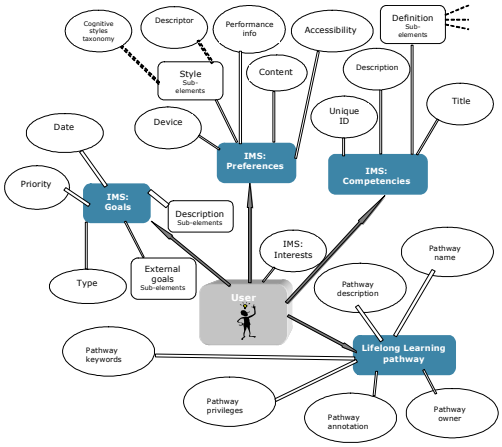

Figure 4. Fragment of the learner model schema.

With respect to access management, the user metadata schema conforms to the *eduPerson* standard, which is an auxiliary LDAP (RFC 2252/RFC2256) object class designed to facilitate communication among higher education institutions [8]. In order to build a user data repository using LDAP it is necessary, apart from eduPerson to use the "person" (RFC2256), "organizationalPerson" (RFC2256) and "inetOrgPerson" (ITU X.521) object classes in order to specify the user personal details.

5 Concluding Remarks

We have presented a personal space for lifelong learners that offers users tools for planning their learning and reflecting on their learning pathway throughout life. The functionalities of the L4*All* system are provided through interaction with external services and components (most of which were open source but originally designed from quite a different perspective and serving a different purpose), and development and integration of several new web services and components. Overall, the L4*All* development process required combining different metadata schemas; extending these with new metadata elements; exchanging data between heterogeneous services; privacy considerations and release policies of user attributes for access management and personalisation; and interoperability between the heterogeneous components of the system. We are currently working on evaluating the alpha version of the system with several different groups of lifelong learners and expanding its community-building and personalisation functionalities. We also plan in the near future to refactor the Web Services component of Figure 3 in order to publicly expose the timeline management and timeline and user searching functionality as a set of independent web services that can be discovered and invoked by other applications, thereby increasing the potential usage and value of L4*All*.

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