

# Designing Services-Enabled Personalisation for Planning of Lifelong Learning Based on Individual and Group Characteristics

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**Abstract.** Lifelong Learning is a complex environment where strategic planning, coordination and collaboration between partners are needed. Lifelong learners form a rather diverse student population with a variety of backgrounds, evolving needs and varying accessibility requirements. Making lifelong learning happen in practice requires learners becoming more aware of their own studying and thinking processes, and tools and guidance that support the planning of learning throughout life. To this end, technology should be 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. Models also need to be developed and frameworks need to be extended that would allow local, regional, national and international systems to work together to provide lifelong learners coherent access to e-infrastructures within and across institutions. This paper explores a lifelong learning dimension in the context of the MyPlan project<sup>1</sup>, which aims to create a personal space where learners are supported in planning their learning throughout life. It investigates the role user modelling can play in this context to support personalisation when searching for new learning opportunities and receiving recommendations, and to facilitate reflection both on learner's individual experiences and experiences of others.

## 1 Introduction

Lifelong learning requires continuous engagement in acquiring and applying new knowledge and skills in order to meet the evolving needs of individuals and organisations. It has created new challenges with respect to understanding, exploring and supporting new learning dimensions, such as self-directed learning, reflection, collaborative and organisational learning, and learning on demand [8].

The emergence of Lifelong Learning Networks (LLNs) and University Federations, [9], [20], which are envisaged as groups of institutions that come together across a city, area or region to offer new progression opportunities for lifelong learners, creates new drivers for change to accommodate the needs of learners who will move between various groups and institutions, and who may work in different countries. Much of this has been made possible by the new possibilities offered by the Internet and the new approaches in systems design [6], [9]. However, the audience of these systems is considerably diverse, as lifelong learners may belong to radically different groups; they come from different backgrounds, and are very much concerned with the accessibility of the various systems within LLNs or federations, the transferring of their personal information for cross-institutional e-learning, and the flexibility of the curricula offered. Thus, new approaches are needed for managing and exchanging performance or competency data between different e-portfolio systems [10], [11], [12], assembling or manipulating fragmented user data that were stored in different distributed systems [6], [20].

The issue of allowing users some level of control over viewing, editing, managing and realising their attributes has been investigated in the context of open learner modelling. A number of

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<sup>1</sup> The MyPlan-*Personal Planning for Learning Throughout Life* project (<http://www.lkl.ac.uk/research/myplan/>) is funded by the e-Learning Capital Programme of the Joint Information System Committee, UK ([http://www.jisc.ac.uk/whatwedo/programmes/programme\\_elearning\\_capital.aspx](http://www.jisc.ac.uk/whatwedo/programmes/programme_elearning_capital.aspx)).

approaches have been developed to maintain and compare learners' own and a system's beliefs about aspects of their user model, such as their knowledge, collaborative peer assessment in discussions, and interactive dialogues [1], [4], [16]. However, in lifelong learning a more holistic approach is needed as is evidenced by the growing adoption of e-portfolios and personal learning planning systems. In this direction, our previous work [2], [3], [19] has investigated how lifelong learners could be better supported in their choices by developing a system which allows users to search for information about cross-institutional learning opportunities, and to create, maintain and share individual 'timelines' of their past and future learning, work and life experiences. We also investigated (see [18]) the exchange of information between such learning planning systems and e-portfolio systems as learners move between institutions.

The MyPlan project is extending this work by aiming to create a personalised space that more effectively addresses the needs of the diverse population of lifelong learners, allowing planning of and reflection on learning and providing personalised recommendation of relevant future learning routes based on previous learning and future learning goals. Building on the earlier *L4All* system of [2], [3], [19], it will allow users to create open information-rich user models that will not only represent their interests, background, qualifications, goals and objectives but will also provide a holistic view of their learning, work and life experiences in the form of a timeline. This approach provides continuity between learning and work experiences and differs considerably from other open learner models in that the learning pathway also integrates social factors, providing support throughout lifelong learning rather than compartmentalising learning into one stage or period.

The paper is organised as follows. Section 2 introduces the learner model, which is defined as an ontology describing the different characteristics of a learner and the relationships between the different concepts. Section 3 presents personalisation services specific to supporting independent lifelong learners in planning their learning and use cases in the context of the MyPlan project. The last section presents concluding remarks.

## 2 Lifelong Learner Modelling

The main driver behind the standardisation of user modelling approaches is to enable interoperability and reusability of user models in order to allow personalisation of web-based systems by integrating the available user models. In this vein, several researchers have argued in favour of generic learner models, as the adoption of a universal set of user model elements and attributes following well-defined rules would facilitate communication and integration between different kinds of user models embedded in different personalised systems.

In [13] a user modelling language, UserML, was introduced as a platform for exchanging data in a ubiquitous environment. Later, in [14], the same authors proposed the General User Model Ontology which uses UserML to represent user models in a way that would enable different systems to represent and exchange user models. Other work [6] has focused on the use of open standards and services to enable other personalised systems to plug into a server-based learner modelling component which gathers data from several sources and use it or contribute data. In [5] a learner profile based on standards and ontologies was described that uses concepts including preference, performance and portfolio for exchanging data, such as competency records, between e-assessment and e-portfolio systems. Ontology-based learner modelling has also been investigated in [16] and [20] with the content of the ontology dependent on the application.

These approaches could also be useful in the context of lifelong learning. Particularly in LLNs and other forms of cross-institutional e-learning, users typically interact with several different distributed applications, all working with their own learner profiles. Representing and exchanging user data is a desirable property in this context and an ontology-based model would potentially facilitate this process.

Below, we introduce an ontology-based user model that has been developed for MyPlan. The ontology, the MyPlan Learner Ontology (MyPlanLO), conceptualises the different characteristics of lifelong learners identified in our previous studies [2], [18]. It defines lifelong learners in terms of concepts, their structure and relationships. It has been developed using *Protégé*, and a partial view on Protégé OWL-Viz is represented in Fig. 1.



**Table 1.** Sample of MyPlan learner model elements, attributes and related system functionalities.

Element	Attributes	Functionalities
Identification	Names, Postal address e-mail, Phone, photo	Access into the system Search and contact others Organise local communities
Accessibility	Preferences, language information, disabilities, learning style	Customise the user interface Categorise users according to preferred language and accessibility requirements
Goals	Learning type, date, description	Search for lifelong learning opportunities Search for “people like me” Organise communities of “similar” users
QCL	Qualifications, certificates, licences, awards, prizes	Filter search results Organise communities according to their QCL
Activities	type, level, date	Recommend lifelong learning opportunities
Competencies	Title, description	Filter content Personalise the content Organise communities according to their Titles
Interests	Hobbies and recreational activities	Capturing user interests could be used to organise communities with similar interests. Personalise the layout Filter the content Recommendations
Evaluations	Type, level	Rate lifelong learning activities and timelines Search for courses
Affiliations	Organisations, educational institutions, employers, government departments	Organise communities of users Filter content Personalise the interface Search for lifelong learning opportunities or other users
Timeline	Owner, keywords, title, privilege, episode	Search timelines that match keywords/title or contain specific episodes Identify “people like me”.

### 3 Services-enabled Personalisation for Planning Lifelong Learning

MyPlan builds on the *L4All* system [3], [19], adopting a service-based architecture following the E-Learning Framework (ELF) specification ([www.elframework.org](http://www.elframework.org)). The ELF is an initiative of the UK’s JISC and Australia’s Department of Education, Science and Training; in June 2006, New Zealand’s Ministry of Education and SURF in Netherlands also became partners. *L4All* integrates tools, common access management services and web services, and also interacts with services provided by external suppliers such as *LearnDirect* ([www.learndirect.co.uk](http://www.learndirect.co.uk)).

Our design approach recognises the central importance of community involvement, and models the process of planning of lifelong learning using services and processes that describe sequences of steps and the services and data involved in each step [2], [3]. Personalisation in this context emerges through aggregation of services that implement system functionalities. It can be materialised by creating, managing and storing user data (e.g. qualifications, interests, goals, learning style), usage data (e.g. ratings, learning opportunities selections from search results, types and levels of courses attended to date), usage regularities (e.g. types of episodes in the timeline and frequency of their occurrence) and relationships between user behaviours from a diverse set of applications running on a LLN using the MyPlanLO (e.g. competencies stored in an e-portfolio system).

Services have been identified through the ELF and a methodology that used a series of workshops, focus groups and interviews with lifelong learners and experts to identify user requirements and evaluate system features and functionalities [2] (see also [18]). These include services for the management of individual learner models and policies for updating, registering user-related data, authorisation and authentication. Table 2 presents a set of personalisation services that are relevant for planning of lifelong learning. Their aim is to enhance individual learners’ engagement with the lifelong learning process by offering control over designing and

reflecting on their learning pathways. Personalisation services can also support building communities of learners with similar interests, and can facilitate information sharing with other members of the lifelong learning community and with peers.

**Table 2.** Sample of MyPlan personalisation services.

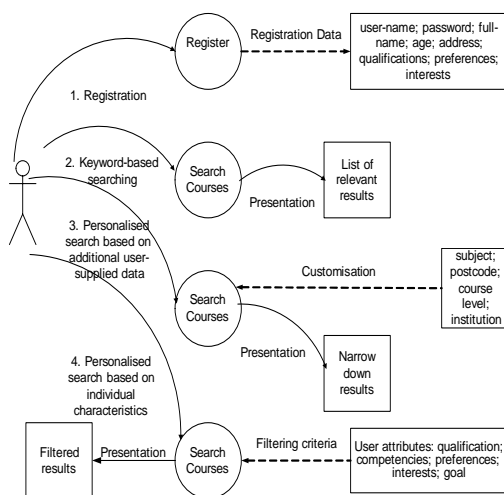
Personalisation Service	Functionality
Search	Searching for content, pathways or peers in a personalised manner by narrowing down or broadening the search depending on the learner model, e.g. preferences and learners' goals.
Ranking	Adaptive link ordering based on self-rating and other users' ratings.
Filtering	Filtering of links about relevant learning opportunities and pathways.
Advertisement	Deliver personalised advertisements about learning opportunities based on user's activity with the system and user preferences.
Customisation	Allow users to update their profile and preferences, activate/deactivate features of the system that depend on user preferences, career and learning goals. Personalise the delivery and presentation of content depending on learner background, preferences and characteristics; receive personalised messages/information, or a calendar that is configured to show only the user's relevant events.
Recommendation	Provide recommendations about other users (people "like me"), i.e. users with similar profiles and/or timelines. Recommendations about courses can be also provided (e.g. courses I should do) by matching properties of the courses with user profile characteristics and learning history.
Similarity	Evaluate similarity measures in order to provide recommendations.
Validation/eligibility	Validate acceptance into next stage of learning by checking whether the learner can access specific modules, or generating warnings regarding irrelevant plans and contradictions in the lifelong learning plan.
Reflective log	Allows learners to record their reflections about parts of their learning plan, e.g. how modules/courses helped them achieve a personal goal. The system can utilise reflections of some users and display them automatically to a particular user with similar characteristics, who shows an interest in the same subject.
Rating	Support for the use of secondary metadata (user ratings and text annotations) for resources. Record rating of search results, lifelong learning opportunities, pathways, implicitly or explicitly.
Automatic profile update	Support the mapping of learner activities in the system against specific competencies, which updates services with user preferences information.
Notification	Monitor learners' favourite timelines, detect changes or modified reflections and initialise services that inform the interested learner about these. Notify users about communication spaces that relate to their interests.
Occupation profile matching	Match user profile attributes with expert-supplied occupation profiles using metadata for courses and professions.
Communication	Create communication spaces for users with similar interests, e.g. developing weblogs with many users/authors that belong to the same community. Access to communication spaces can be personalised to meet the needs, interests and preferences of particular user groups.
Classification	Categorise users into groups for use by other personalisation services. This can be achieved by grouping according to user stereotypes, by grouping individual user models that share similar attributes, or both.
User support	Provides support regarding the use of various system features and functionalities.

The ontology approach is eminently suitable for categorising and associating a user with a specific stereotype dynamically, as assumptions about a learner's characteristics can be inferred automatically whenever any changes occur to a particular concept, property or relationship representing learner-related information. For example, personalised searching and filtering of results or recommendations can be generated based on specific stereotypes (particularly when the system is used within the context of a LLN). Moreover, maintaining the ontology as new groups of users are formulated through clustering based on the similarity of their goals, timelines, competencies and other relevant user attributes can facilitate generating recommendations based on group characteristics. For example, when a user rates or comments on a timeline or a course,

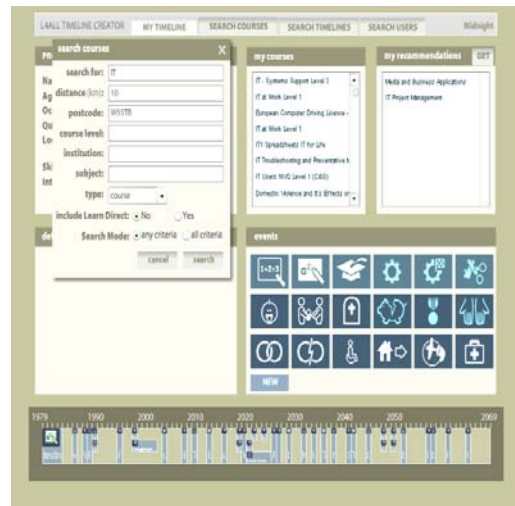
the system could notify other interested members of the same group automatically. Services-enabled personalisation requires user and usage data, usage regularities and user behaviours coming from the wider networked environment to operate. While some of these data may provoke users' privacy concerns (e.g. transferring personally identifiable information, validating qualifications, and importing reflections from other systems), we have found that other data, such as timeline episodes and goals, are willingly shared among peers [18]. There are a number of approaches for privacy-preserving personalisation [17]. The approach explored here combines users' participation in setting privacy preferences (e.g. about their timelines) with Shibboleth<sup>2</sup> federated access management [20] adopting the *eduPerson* standard [7].

### 3.1 Personalisation Scenario Based on Individual Characteristics

Fig. 2 illustrates a "Search for courses" scenario as an example of individual level personalisation. Kim completed her secondary school. She registered on the system and starts looking for courses on IT. There are thousands of them, and she is a little dispirited. She refines her search by specifying that she wants a short course satisfying a set of search criteria e.g. subject, location (by postcode), level. This customises her search and narrows down the list of courses, but there is still a wide range of options available to her. She is still not quite sure what she should do, so she selects an option to filter the search results according to her learner model.



**Fig. 2** Personalised searching for courses based on individual characteristics and preferences



**Fig. 3.** Searching for courses and receiving recommendations. User's timeline appears at the bottom. Users can drag and drop icons to add episodes to their timelines.

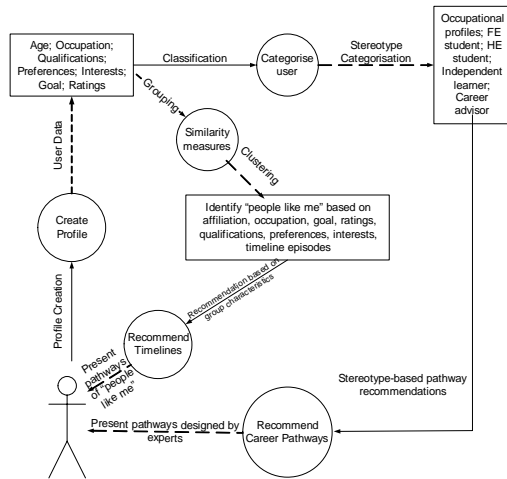
Fig. 3 shows a screenshot of the system. The user's timeline is shown at the bottom of the screen. Among other options, the user can search for courses/learning opportunities. The "my courses" list presents a customised view of the search results, while the "my recommendations" lists contains courses relevant to this user which have been identified by matching with predefined learning pathways designed by educational experts and stored in the system.

### 3.2 Personalisation Scenario Based on Group Characteristics

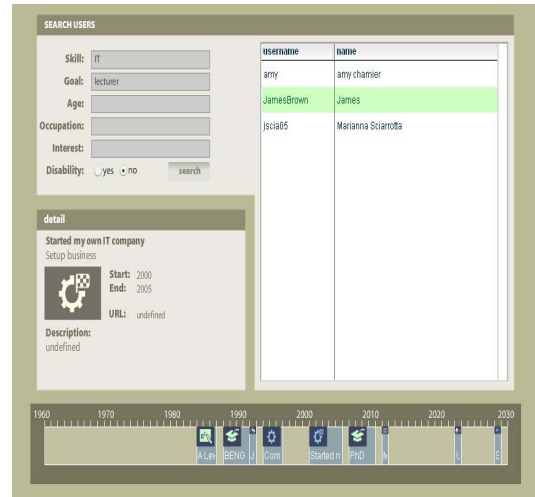
Fig. 4 presents an example personalisation that exploits characteristics which are similar among learners. Jack is interested in planning his lifelong learning. In order to create the timeline representing his lifelong learning pathway, he first creates his profile. The system categorises Jack

<sup>2</sup> Access management protocol designed to facilitate communication among UK higher education institutions.

automatically into one of the static stereotype groups already existing in MyPlan. Based on that, Jack will be recommended a list of existing timelines for users that belong to this stereotype group. This will help Jack in designing his own timeline and will allow him to communicate with people “like him”. Alternatively, a more effective recommendation can take place whereby similarities between Jack and other users are identified by matching Jack’s and other learners’ characteristics. This can be achieved using a clustering technique that takes into account learner model items such as current occupation, interests and learning goal. The interface of Fig. 5 allows users to specify criteria that can be used to identify similar users.



**Fig. 4.** Generating recommendations based on group characteristics and users similarities.



**Fig. 5.** Identifying “people like me” and relevant timeline.

## 4 Concluding Remarks

This paper has discussed an ontology-based approach for modelling the user and ways to personalise users’ interaction in the context of MyPlan, a system that aims to support the independent lifelong learner. MyPlan operates using web services, and uses standards-based technologies and open specifications. In a lifelong learning environment, an ontology-based approach is a good candidate for developing interoperable systems and learner models that can serve various e-learning systems for various purposes. A standards-based architectural approach can facilitate collaborative cooperation between different systems, enriching systems with user-related information in order to afford a suitable level of personalisation. The paper has proposed a list of personalisation services for planning lifelong learning and has illustrated application scenarios of personalisation services that use various related learner model items operating at the individual and the group level.

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