



Extending web-based educational systems with personalised support through User Centred Designed recommendations along the e-learning life cycle



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HIGHLIGHTS

- User centred design translates educators' expertise to the adaptation process.
- Adaptation support can be managed along the e-learning life cycle.
- Recommendations can enrich LMS with adaptive navigation support.
- Learning outcomes in MOOC improve with user centred recommendations.

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ABSTRACT

In this paper we address an open key issue during the development of web-based educational systems. In particular, we provide an educational-oriented approach for building personalised e-learning environments that focuses on putting the learners' needs in the centre of the development process. Our approach proposes user centred design methodologies involving interdisciplinary teams of software developers and domain experts. It is illustrated in an adaptive e-learning system, where a MOOC (Massive Open Online Course) was taken by nearly 400 learners. In particular, we report where user centred design methods can be applied along the e-learning life cycle to designing and evaluating personalisation support through recommendations in learning management systems.

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1. Introduction

As discussed in this paper, User Centred Design (UCD) approaches can be used to enrich the personalisation capabilities of web-based educational systems with adaptive navigation support through recommendations. From our experience, personalisation cannot be designed in advance as a plug-in in the e-learning environment, but it has to be constructed in a process that considers and involves learners' needs from the outset and during the whole e-learning life cycle (eLLC). To cope with this need, we propose the adoption of a UCD approach during the development of adaptive e-learning systems, involving interdisciplinary teams of software developers and domain experts. As a result, we have come up with a solution for building personalised e-learning environments that has shown a better support for teaching and learning activities by putting the user in the centre of the development process. This is a long-standing challenge during the development of

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services and functionalities for new e-learning solutions and is becoming critical when developing Massive Open Online Courses (MOOCs) that are to cope with individual learners' needs.

In order to address this challenge, at aDeNu research group we have been working for more than a decade on how to take adaptation along the eLLC by designing and delivering educational-oriented recommendations. In our methodology, four phases are handled in this cycle: i) design in advance the learning experience, ii) administrate the environment where the learning experience is to be carried out, iii) interact (learners and educators) with the e-learning services, and iv) feed the results on the learning experience back to the course author. Here, adaptation is delivered by personalised recommendations through a Semantic Educational Recommender System (SERS). In previous works we have partially presented the basis of this approach, but we have not reported how each of these parts can be combined along the development cycle of the e-learning system to provide the required functionality. Neither, we have reported the results of a large-scale evaluation covering all the cycle stages to validate the approach.

These partial advances have been achieved within some of the research projects developed at aDeNu. In particular, the grounds for the definition of the stages in the eLLC, the need to involve all the actors of the learning process and the idea of combining design and runtime adaptations making a pervasive use of educational standards were settled in the aLFanet project (IST-2001-33288) [1,2]. Following these, in the ALPE project (eTEN-2005-029328) usability and accessibility issues were included in the eLLC [3]. Finally, in the EU4ALL project (IST-2006-034778) we deepened on the previous ideas and defined an open standard-based service-oriented architecture to extend the personalisation capabilities of learning management systems (LMS) in an inclusive way [4,5], set the foundations for the UCD TORMES methodology to help educators elicit and design educational-oriented recommendations [6,7], proposed the recommendation model that bridges the gap between the educators' descriptions and the software components' information exchange [8,9] and drafted the system requirements to instantiate elicited recommendations within the LMS [10]. Based on these works, an approach to extend e-learning systems with personalised support with user centred designed recommendations along the eLLC is proposed.

This approach has been tested in a real world e-learning scenario by deploying a MOOC through Willow web-based educational system enriched with user centred designed educational-oriented recommendations. Willow is a computer-assisted assessment system of free-text answers successfully used in blended learning [11]. The integration of the SERS approach in Willow was outlined in [12]. As addition to the work reported there, this paper provides details on the user centred development and evaluation process carried out along the eLLC by an interdisciplinary team of software developers and domain experts to extend Willow's adaptive capabilities in order to provide learners with the required adaptive navigation support. In particular, in this paper we provide some practical guidelines that focus on reporting where UCD methods can be applied along the eLLC to designing and evaluating personalisation support in e-learning systems through recommendations.

The paper is structured as follows. First, some background and motivation is introduced. Then, our approach to consider personalisation along the eLLC is presented. After that, we report its application to produce user centred adaptive support in the aforementioned MOOC. Finally, some discussion, conclusions and future work are outlined.

2. Background and motivation

Adaptive e-learning systems have undergone considerable changes over the last decade [13]. There have been research prototypes [14] but still personalisation in e-learning is a long-standing open issue [15] and there is not currently any system that supports full adaptivity [16,17]. A straightforward way to provide adaptation in LMS is via adaptive strategies like adaptive ordering, link hiding, and adaptive link annotation with the aim to tailor the learning experience to each individual learning need [18]. In this context, LMS can be seen as a large space of educational information sources and interaction items, which include not only the educational contents, but also contributions produced and shared by members in the course (e.g. forum posts, external links, etc.). These potential navigation paths involve an increasing number of possible actions to take in the course space [19]. However, although LMS are holding large volumes of interaction data, they do not integrate any data mining support to evaluate the course space structure and its effectiveness on the learning process, aimed to develop smarter scenarios that enhance the learning experience [20]. For this reason, data mining services that can be integrated into LMS to support educators (non-experts in data mining) in the data mining process are being proposed [21].

Recommender Systems (RS) are also being integrated into LMS to reduce the existing information overload and extend their capabilities with adaptive navigation support [22]. This integration can be carried out following a modular approach based on building components that support different services that can be integrated into different platforms, as devised for the next generation of LMS [23]. More specifically, service-oriented architectures can contribute to improving the personalisation capabilities of LMS [24,25], for instance, by integrating external services that manage the learner model upon which the adaptation can take place. In the same vein, standardisation approaches towards the Web 3.0 are being carried out, aiming at enabling interoperability with existing services and developments at different institutions [26]. In this context, one of the most holistic standardisation approaches in education is the set of specifications developed by IMS [27], which include, among others, the Learning Design specification. IMS Learning Design offers the explicit semantic description that can be managed by educators in providing adaptive learning paths [28]. Similar information is also relevant for adaptation purposes in educational RS (ERS) [29].

A relevant issue from the user viewpoint is the concept of usability, defined the standard ISO 9241-11 as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in

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