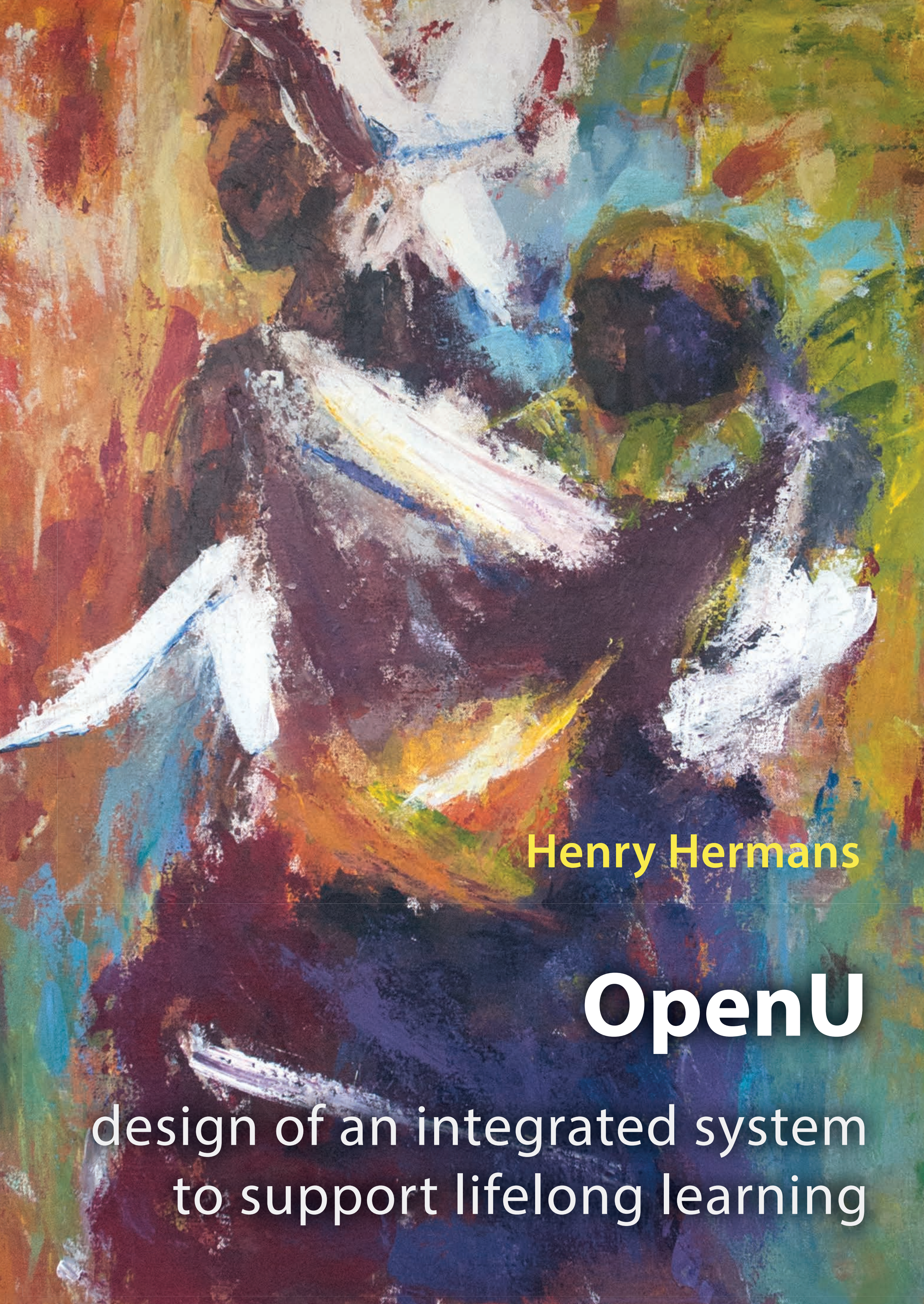
# OpenU: design of an integrated system to support lifelong learning



Henry Hermans

# OpenU

## design of an integrated system to support lifelong learning

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# OpenU: design of an integrated system to support lifelong learning

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# General Introduction

# 1 Introduction

This thesis describes the design and first implementation of an online system for lifelong learning, that enables educational institutions to adapt the learning process to identifiable groups of adult learners, in other words to facilitate *segmented personalization* (Martinez, 2013). The development of this learning system is a new step in a tradition of open and flexible learning at the Open University of the Netherlands.

The learning platforms we nowadays know as virtual learning environments (VLEs have become an almost indispensable part of the teaching and learning infrastructure of universities and colleges (Brown, 2010). They have been typically designed for formal instructional purposes, according to the requirements of the dominant educational culture in our western world. This educational culture dates back to the industrial revolution of the 19th century, when mass production became a fact. This marked the start of public, compulsory education, driven by economic motives of that time.

*"Our education is modelled on the interests of industrialization and in the image of it. Schools are very much organized on factory lines, ringing bells, separate facilities (e.g. for boys or girls), specialized separate subjects. We educate children by batches, put them through the system by age group. It reflects a production line mentality."*
Ken Robinson, 2010.

The widely recognized demand for *lifelong learning* requires a different model for education, and, as a consequence, a new generation of institutional learning platforms. Lifelong learning relates to all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competence, within a personal, civic, social and/or employment-related perspective (European Commission, 2000). It requires an educational model that Longworth (2003, p113) concisely summarizes as follows: "Teaching for the year 2020 requires an education system that instils attributes of adaptability, flexibility and versatility into its victims".

Learning platforms for lifelong learning should support a heterogeneous population of adult learners, differing in prior education, age, living and working environment, available time to study, need for structure, and willingness to study with others. They should facilitate the process of self-directed learning, "[…] by which individuals take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identify human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975).

## 2 Background

Adapting education to the requirements of the lifelong learning[1] requires putting the individual learner at the stage instead of the teacher, and handing over control of learning more and more to the learner in order to become self-directed. Within lifelong learning, informal learning, i.e. the kind of learning that takes place in the course of daily life, spontaneously and in non-structured way (Coombs, Chappells, & Shove, 1985), takes a prominent place. People learn in a variety of contexts, intentionally or unintentionally. These contexts may be designed to support learning, but probably most of them are not. Learning may take place in the workplace, on the job, by participating in social networks, while browsing the Internet, or just by having a good conversation with friends. There are estimates that 70% to 90% of learning is informal (e.g. Livingstone, 1999). Learning is a process we are still investigating, but which eventually results in a change in behaviour or the capacity to behave in a given fashion (Schunk, 2012).

A dominant digital technology that seamlessly fits in the traditional educational culture is that of the virtual learning environment (VLE), also known as learning management system (LMS). VLEs have become an almost indispensable part of the e-learning infrastructure in schools and universities. They have been typically designed for formal instructional purposes, providing common features for content creation, communication, (formal) assessment and administration (Dabbagh & Bannan-Ritland, 2005). They replicate traditional models of learning and teaching in online environments (Mcloughlin & Lee, 2010). As such they meet the demands of educational institutes, not so much those of (individual) learners. Lifelong learning imposes new requirements, such as learner-control and learner orientation, and integration of both formal and informal learning.

The role of informal learning receives increased attention from educational institutions. This is reflected, for instance, in trends like offering services for recognition of prior learning (Joosten-ten Brinke, 2008), and initiatives to incorporate and encourage the use of social media in VLEs. In 2012, the OU UK launched the SocialLearn platform, which is particularly designed for informal, personal learning (Ferguson & Buckingham Shum, 2010). The platform combines open educational resources and social networking tools, allowing users to connect and share learning artefacts. Another example is the European Trailer project (2011-2013) in which tools have been designed and piloted to

1 Throughout this thesis, both the concepts of lifelong learning and adult learning are used interchangeably, as the research described here is carried out within the context of the Open University of the Netherlands, which provides education to learners from the age of 18.

make informal learning experiences visible within 'formal' contexts, e.g. education and human resource (Brouns, Vogten, Janssen, & Finders, 2014; Conde et al., 2013).

An important response to the growth and orientation of the institutional VLEs is the concept of the Personal Learning Environment (PLE), introduced by Olivier and Liber (2001). Within this concept learning and management of learning by learners themselves are key. It starts from the premise that the learner is responsible for learning, which aligns perfectly with the principles of lifelong learning, i.e. giving the learners the tools and techniques they can use to realize their learning needs according to their own preferences. To this end the learner should be equipped with tools for organizing, customising and shaping his/her personal environment. This implies tools for processes such as planning learning activities, searching for and connecting to peers, collecting, organizing and sharing resources, knowledge creation and sharing, reflection and evaluation. This thesis outlines the work carried out at the OUNL to address the needs of adult learners. It describes the design, development and implementation of an integrated learning system 'OpenU', which supports educational providers, teachers, and learners in creating flexible, personalized learning opportunities, integrating both formal and informal learning. Mcloughlin & Lee (2010) argue that pedagogic change and greater personalization of learning are both necessary for student centred, self-regulated and independent learning. Learner control and self-regulation are key values in lifelong learning. Before describing the aim and structure of this thesis, we first take a closer look at the concept of personalization.

## 3 Personalization

In the context of learning and teaching, the concept of personalization refers to adapting the learning process to personal preferences and characteristics of learners. This means accommodating education to personal goals, personal learning strategies, personal needs and circumstances, and preferences for assessment of learning outcomes. Although the concept of personalization doesn't necessarily imply the use of information technology, it is usually associated with it (e.g. Aviram, Ronen, Somekh, Winer, & Sarid, 2008; Martinez, 2013).

Personalization in learning environments may take different shapes stemming from a variety of motives. Reasons for personalization may be rooted in beliefs and theories about learning, for instance theories on learning styles (Kolb, 1985; Lu, Jia, Gong, & Clark, 2007; Peterson, Rayner, & Armstrong, 2009; Vermunt, 1992) or theories on motivation and retention in education (Kember, 1995; Vincent Tinto, 1987), or it may have a more trivial, customer relation or marketing background, as is the case for instance in simple name recognition.

Martinez (2013) suggests five strategies or approaches to personalization, ranging from *name recognized personalization*, making it more personal for the learner and acknowledging the learner as an individual, to *whole-person personalization*. Within this framework all personalization approaches presuppose the use of technology and a formal context.

Aviram et al. (2008) introduce the concept of self-regulated personalized learning (SRLP). Personalization of the learning process is maximized in order to maximize self-regulation. Adaptation is the result of the choices of the learner (self-personalization). Learning is expected to be more authentic and motivating in this way.

For the design and implementation of personalization in a learning system the following questions should at least to be considered:

- *What is personalized?*

  Many online computer systems, including learning management systems, provide user interface adaptation such as name recognized personalization or different rendering of services and content to allow for ubiquitous learner access. Although the learner may certainly benefit from this, it is not so much related to the core of the learning process, which has the focus in this thesis. In this respect, the conceptual model of IMS Learning Design (IMS Global Learning Consortium, 2003), a specification for describing teaching and learning strategies, provides a useful framework (Koper & Tattersall, 2005). Following this model personalization may affect:

  (1) the (type of) learning activities;
  (2) the learning environment, i.e. resources and services (tools) required or needed to carry out the learning activities;
  (3) the play, i.e. the learning process: which roles perform which activities in what order?
  (4) an additional category to be distinguished beyond the realm of a single course or unit of learning is the learning path, which extends to an entire program, indeed a series of programmes and which may also include informal learning (Janssen, Berlanga, & Koper, 2011).

- *Who controls the personalization process? The learner or the learning system (ergo the institution)*?

  The aspect of control is discussed by Miller et al (2005) in terms of adaptive versus adaptable systems (see also Burgos, Tattersall, & Koper, 2007). Adaptive means that the system controls and decides about the adaptation, whether or not in interaction with the user. On the other hand, adaptable refers to the situation in which the user makes choices about the adaptation. Aviram et al. (2008) characterize the situation in which the learner is highly responsible for making the decisions, and thus controlling the adaptation process as 'self-personalization'.

The personalization process here is explicit, based on learners' choices. The adaptation is the recognizable and traceable result of these choices. In contrast, the process of 'automated personalization', where the (learning) system fully controls the adaptation, usually takes place implicitly. Here the learner is not that much aware of what has been adapted. Think of the example of the web, where you may not be aware of any adaptation until you notice that the same web page is displayed differently on your colleague's computer (different ads, or different search results for the same query).

- *On what information is the personalization algorithm*2 *based?*
  Algorithms for personalization make use of various user related data, such as learner *profile* data, learner *behaviour* or usage data, and learner *environmental* data. Learner profile data deals with data about the learner, such as personal information, personal networks and group memberships. Learner behaviour information relates to learner's digital footprints, data that has been recorded by acting and interacting in the learning system. Learner data can also be aggregated in order to generate learner stereotypes indicating similar behaviours or characteristics (Kobsa, 2004). This can be used, for instance, for selecting or recommending learning paths. In addition, learner *environmental* data, such as the learner's geographical location, can be used to select the learning activities to be performed.

### 3.1 A tradition of open and flexible learning at the Open University of the Netherlands

In 1982 Sony launched the first consumer compact disc player (model CDP-101) and the computer was elected as Times man of The Year. In the same year the Open University of the Netherlands (OUNL) started the development of a new, different type of higher education in the Netherlands, following the example of the Open University of the UK (Verkuylen, 1994). Open was the key concept in the educational approach in order to create a maximum of flexibility. Open in place, time and pace, but also open in the sense that students themselves could determine their study goals, and had all sorts of choices in the composition of programmes (cross disciplinary), no formal barriers to enrolment, thus creating a high level of flexibility for its students.

In the early 90s, the digital revolution took up speed with the rise of the World Wide Web. The OUNL responded to the new developments with Studynet [Studienet], an 'in-house' developed e-learning system, built by OUNL's educational research and development department. The OUNL was the first university in the Netherlands

[2] In mathematics and computer science, an algorithm usually means a small procedure that solves a recurrent problem (http://whatis.techtarget.com/definition/algorithm).

implementing online learning (Schlusmans et al., 2009). High dropout rates have always been one of the major problems in classical distance education, where interaction between students and between students and teachers was restricted to a minimum. Online learning was considered a means to overcome these restrictions. The Studynet system offered each student a personalized workplace with access to courses, news, and learning and communication facilities. Newsgroups were being deployed for formal as well as for informal communication to foster bonding amongst students. Note that the Blackboard company, nowadays one of the leading vendors in the VLE market, was founded in the same year (1997) the OUNL launched Studynet.

In 2002 the OUNL announced Edubox (Tattersall, Vogten, & Hermans, 2005), a new e-learning system, as part of its teaching and learning infrastructure. In a tradition of flexible, student-centred education, the OUNL had developed a platform that allowed for detailed personalization of the learning designs of courses and programmes. The core functionality of this system was the delivery of learning designs, specified in a formal, pedagogical language: Educational Modelling Language (EML; see Hermans, Manderveld, & Vogten, 2004; Koper, 2001), the predecessor of the IMS Learning Design specification. By using personal properties and an integrated condition language, as also present in IMS LD level B, a wide range of personalization strategies could be implemented, controlled by the system (adaptive), or controlled by the learner (adaptable). For instance, learners could choose between different pedagogical approaches within a course, based on personal preferences, or suggested by the system, on completion of a learning style test. In another example, the set of learning activities was adjusted based on assessment of prior knowledge. However, at that time the system appeared to be too ambitious. Hampered by the lack of user-friendly (authoring) tools, the system didn't reach a large-scale application.

In the following years, inspired by the rise of web 2.0, marking a change from an information-centred web to a user-centred web, and the successful emergence of social networks, research and development activities at the OUNL focused on the development of the concept of Learning Networks (Koper et al., 2005), particularly meeting the demands of lifelong learning. A framework of learning networks, incorporating formal as well as informal learning was developed, and implemented within the European TENCompetence project in the period 2005-2009. A learning network in its essence is a technology supported community of people in some discipline who are helping each other to better understand and handle certain events and concepts in work or life (Koper, 2009b). It supports people in managing their competences, by providing services that facilitate them to have ubiquitous access to the network, to navigate through the network, to position themselves in terms of competences and knowledge, to find other people who can help them answering questions, and to get the support of peers and other professionals.

Learning networks follow a user-centred, learner-controlled model of distributed learning (Koper et al., 2005). Although a major part of this learning may have an informal character, this doesn't exclude formal learning. For effective and efficient competence development a mixture of both formal and informal learning may be required.

With lifelong learning growing on the societal and political agenda, the OUNL unfolded in 2008 a new strategy for the delivery of education, originating from the ambition to give open educational resources (OER) and lifelong learning a sound position. A new business model was developed, described through a 'concentric circles model', dividing the target population into several groups, each group to be served with a tailored collection of online educational services. To meet the changing business requirements, the OUNL started in 2009 with the design and development of OpenU, an integrated, learner-centred system for lifelong learning. Integration relates to an architecture, in which the concepts of PLE, VLE, SNS and OER are joined. As a general framework the concept of learning networks is adopted. The ambition is to create one single point of access for the adult learner, to a learning network that empowers the learner with tools for personal learning management, and provide a range of opportunities for formal and informal learning.

## 4 This thesis: aim and design questions

This thesis is about the design of a new, online learning system to support lifelong learning in the 21st century. The learner-centred character of lifelong learning implies handing over the responsibility for learning (as much as possible) to the self-directed learner. For educational institutions that want to adopt lifelong learning in their business strategy, this implies transitioning from a teacher-centred model to a learner-centred model. First of all, this will mean a huge, cultural shift within most organizations, as pedagogical models and supporting tools may be deeply rooted in traditional, teacher-centred models of teaching and learning. Most teachers, managers, and support staff have been raised within the industrial teaching and learning paradigm. Second, it calls for different strategies for developing and delivering courses and programmes, which suit the needs and requirements of a heterogeneous group of learners. To be able to adapt to individual preferences and characteristics of (groups) of learners, requires a high degree of flexibility in educational services offered. Finally, it means developing and implementing ideas and models on how to support informal learning.

The main question to be answered in this thesis is whether it is possible to design and develop an integrated learning system which allows adult learners to plan, execute and manage their personal learning ambitions, whether in a formal or in an informal setting. A further question to be answered in support of this ambition is how to support the organization in order to provide the necessary flexibility within their institutional offerings to meet the demands of personalization.

The methodology used in chapters 3 to 5 of this thesis follows to a large extent the tradition of design-based research (Anderson & Shattuck, 2012). The research described in these chapters is situated in a real learning and teaching context, focussing on the design and application of new approaches to support lifelong learning, and carried out in close cooperation with teachers and faculty managers. Following the design questions, conceptual models have been created to support theorizing as well as practical applications that work.

As a prelude to the core chapters of the thesis, chapter 2 describes earlier work carried out at OUNL and referred to the above, aimed at increased flexibility and personalization: the Educational Modelling Language (EML). This language, predecessor to IMS Learning Design (Koper, Olivier, & Anderson, 2003), was designed in particular to create more pedagogical flexibility, having personalization as one of its key requirements. The development of this language was an early, though important step, towards instrumentation of effective, efficient and attractive integrated e-learning environments. The chapter describes the general requirements and the pedagogical meta-model that led to the design of EML. It outlines the core parts of the language and illustrates how both adaptivity and adaptability can be achieved by using this language to design learning. This chapter also serves to illustrate how previous work regarding personalization, focused on pedagogical flexibility of learning designs in a formal learning context, whereas the work described in the following chapters aims to provide a learning environment that supports and integrates both formal and informal learning.

Chapter 3 presents the design of an integrated, learner-centred system that addresses the adult learner. This system has been developed against the background of relatively high dropout rates and renewed, intensified attention for lifelong learning at the OUNL. The actual educational distance teaching model is flawed, due to the lack of social bonding and does not account for individual differences and preferences. The e-learning platform in use is still very much rooted in the traditional extended classroom concept. Recent developments regarding personal learning environments, and the rise of social networks inspired the central design question: *Can we design and implement an e-learning system that integrates the concepts of VLE, SNS and PLE?*

To answer this question, we gathered requirements and developed a conceptual model for learning, uniting the contexts of formal, informal and self-managed learning. The model has been implemented in the OpenU e-learning system, and was piloted within an MSc in Learning Sciences.

As has been argued, to address the needs of the professional, lifelong learner, an integrated approach to learning is required. For an educational institution that wants to adopt an integrated approach, and wants to configure its learning environment accordingly, managers and teachers will have to make a shift in their thinking about learning and teaching. This implies handing over ownership of learning to the learner, and "moving teaching from the concept of 'the sage on the stage' to the idea of 'the guide at the side'" (Longworth, 2003; p11). Furthermore, they should be equipped with appropriate tools to implement this approach.

Against the background of a new business strategy, described through a 'concentric circles model', in which various learner target groups were addressed, each to be served with tailored services, the core question addressed in chapter 4 therefore is: *how to develop a system that facilitates efficient authoring and delivery of online courses that satisfy the concentric circles model?*

Key aspects of the approach described in this chapter are (1) the integration of authoring and delivery tools in one system and (2) the use of templates to standardize aspects of the learning design. A first implementation within the OpenU system is described, including figures on usage, again, in the domain of learning sciences.

Offering flexible course configurations requires a logistic process that will become very difficult to manage manually with a growing amount of learners. This relates in particular to the provisioning process, that deals with which teaching and learning services and facilities are to be made available or revoked, to whom, when, and how. Rather than implementing a provisioning policy directly in an e-learning environment, provisioning rules should be made explicit and manageable in order to allow for highly flexible provisioning and reducing workload. Hence, the central design question addressed in chapter 5 is: *Can we design a system that suits flexible, online provisioning and management of the underlying business rules?*

To this end, we have developed a conceptual model for online provisioning (EPS), concentrated around the concept of *course access levels* (CALs), i.e. course configurations that are tailored to particular learner target groups. For reasons of efficiency we suggest an architecture in which the EPS is loosely coupled to the applications in the teaching and learning environment. A first EPS implementation at the OUNL is presented and discussed. Finally, chapter 6 provides a review of results, main conclusions and input for further research.

# Chapter 2

# Educational Modelling Language

This chapter is based on: Hermans, H., Manderveld, J., & Vogten, H. (2004). Educational modelling language. In W. Jochems, J. Van Merriënboer, & R. Koper (Eds.), *Integrated E-learning, implications for pedagogy, technology and organization* (pp. 80–99). London: Kogan Page.

# 1 Introduction

This chapter deals with an open learning technology specification called Educational Modelling Language (EML, 2000). EML is defined as ‘a semantic information model and binding, describing the content and process within a “unit of study” from a pedagogical perspective in order to support re-use and interoperability’ (Rawlings, van Rosmalen, Koper, Rodríguez-Artacho, & Lefrere, 2002). The development of this language should be seen in the broad perspective of working towards instrumentation for the creation of effective, efficient and attractive integrated e-learning environments. In chapter 1 it was stressed that requirements for e-learning environments are becoming more complex, thereby increasing the need for an integrated approach. The challenge for the development of EML has been to adhere to these requirements.

In this chapter we provide a closer look at EML (version 1.0) and its background. First we discuss the general requirements that have led to its design and development. These requirements have led among others things to the construction of a pedagogical meta-model to meet the demands of pedagogical flexibility. The meta-model is discussed, and we then go on to describe the conceptual structure of EML and the corresponding XML-binding. We continue with describing a series of design steps needed to implement a pedagogical design in EML, and show how EML can be used for personalization of learning. We conclude with a word on the evolution EML has undergone in a worldwide perspective.

# 2 Requirements

Koper (2001) summarized the eleven requirements that an educational modelling language should meet as follows:

- *Formalization:* EML must be able to describe pedagogical models formally, so that it is machine-readable and automatic processing is possible. This is arguably the most important requirement for an e-learning environment, as it is the guarantee that the resulting binding can be processed by computers. The requirement implies that EML should be a formal language, with its own alphabet, words and syntax.
- *Pedagogical flexibility:* EML must be able to describe units of study that are based on different theories and models of learning and instruction. This requirement has been derived from the changing landscape of training and education. New paradigms of teaching and training are a fact of life now. For instance competency-based learning (Schlusmans, Slotman, Nagtegaal, & Kinkhorst, 1999), collaborative learning (Dillenbourg & Schneider, 1995), performance improvement approaches (Robinson & Robinson, 1995). Most of these new learning paradigms are based on constructivist principals (Brown,

Collins, & Duguid, 1989). In order to support these new paradigms, learning environments need to be rich, flexible and available at any time and in any place (Manderveld & Koper, 1999). However, most e-learning environments do not support a variety of pedagogical models. Instead they provide their own pedagogical premises, implicit or otherwise, or no pedagogical model at all.

- *Explicitly characterized learning objects:* EML must be able to express the semantic meaning of different learning objects within the context of a unit of study.
- *Completeness*: EML must be able to describe a unit of study completely, including all the characterized learning objects, the relationship between the objects and the activities and the workflow of all students and staff members with the learning objects.
- *Reproducibility*: EML must describe the units of study so that repeated execution is possible.
- *Personalization*: EML must be able to describe aspects of personalization so that the learning materials and learning activities can be adapted based upon preferences, prior knowledge and educational needs.
- *Medium neutrality*: Wherever possible, the notation of units of study must be medium neutral, so that it can be used in different publication formats, such as the web, paper, e-books or mobile phones.
- *Interoperability and sustainability*: The description standards and interpretation technique must be separated. In this way, investments in educational development will become resistant to technical changes and conversion problems. Educational institutes are increasingly faced with large investments in infrastructure and the problem of rapidly changing technology particularly when course development and delivery are integrated into technology. Most e-learning environments develop and store courses and their contents in proprietary formats. As a result it becomes difficult or even impossible to export these courses and content to other formats (Koper, 2003). Cross-platform exchange of content is hardly possible. The only possible solution is often to convert the content manually, which can be a time-consuming and expensive.

  Interoperability can be defined as 'the ability of a system or a product to work with other systems or products without special effort on the part of the customer' (http://whatis.com). The key issue in this respect is to create and manage information in such a way that opportunities for exchange and reuse of information, either within or between institutions, are maximized (Miller, 2000).
- *Compatibility*: EML must match available standards and specifications.

- *Reusability*: EML must make it possible to identify, isolate, decontextualize and exchange useful learning objects, and to reuse these in other contexts.
- *Life cycle*: EML must make it possible to produce, mutate, preserve, distribute and archive units of study and all the learning objects they contain.

## 3 Pedagogical meta-model

The requirement for pedagogical flexibility was described above as the demand that the language to be designed should enable elaboration of different theories and models of learning and instruction. In order to meet this demand a *pedagogical meta-model* has been designed, neutral to the different approaches to learning and instruction. The essence of such a meta-model should be that it models other pedagogical models (Koper, 2001), which implies that it serves as an abstraction. Specific pedagogical models, such as problem-based learning models or collaborative learning, are to be described in terms of the meta-model that is based on research and literature on learning and instruction, and instructional design theories (e.g. Reigeluth, 1987, 1999; Stolovitch & Keeps, 1999).

The meta- model consists of four axioms (Koper, 2001):

1. People learn by performing activities in an environment in interaction with that environment. This is the most important axiom. When a person has learnt, he or she is able to perform new activities netter or faster in similar environments, or is able to perform the same activities in different environments.
2. An environment consists of a set of objects and/or human beings that are related in a particular way.
3. A person can be encouraged to perform certain activities when:
    a. this person, given the requirements in terms of prior knowledge, personal circumstances and the performance context, can perform the activities;
    b. the required environment is made available;
    c. the person is motivated to perform the activities.
4. What has been stated here with respect to a single person, also applies to a group of persons.

It can be concluded from the axioms that instruction should consist of providing students with coherent series of activities, including specific learning environments, so that learning actually can take place.

# 4 Educational Modelling Language

EML has been developed based on the requirements in section 2 and the pedagogical meta-model in section 3. Below, EML will be discussed from different points of view.

## 4.1 Conceptual structure

The conceptual model of the structure of EML is based upon the pedagogical meta-model. The basic idea is shown in Figure 2.1. The smallest autonomous part in education is labelled a 'unit of study'. A unit of study can take any form (course, workshop, lesson or whatever) depending on its pedagogical function. Within the unit of study, there are always one or more roles that can be defined, starting with the student role.

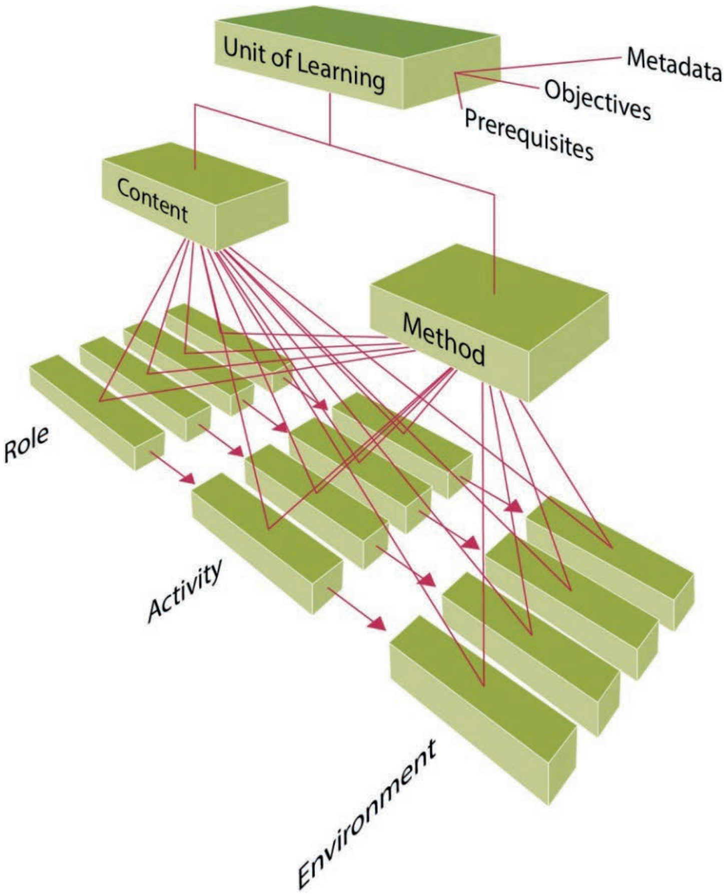


**Figure 2.1.** Basic structure of EML

Students learn by doing things (‘activities’) in a specific context (‘environment’). These activities are in fact the stimuli offered to the student to actuate learning. Examples of activities are attending a lesson, studying a chapter, solving a problem, preparing a presentation and so on. However, these activities are not performed in a vacuum, but in a specific setting or environment. This environment consists of all kinds of objects such as books, readers, teachers, fellow students and libraries to make the actual learning possible. This model applies to any pedagogical approach. In this respect EML should be able to handle all pedagogical orientations.

The *personalization requirement* has been elaborated as follows. EML units of study contain all components that can create personalized learning paths based on individual student characteristics. The decision on which characteristics are used and the way they influence the learning path is the choice of the educational designer. Show and hide conditions make it possible to provide the students with adapted units of study that fit their profiles. Parts of a unit of study that may hidden or shown may vary from specific content parts (such as a text section) to entire activity structures. Students’ profiles are created from a combination of variable student properties. These properties may be set by students themselves, by other actors involved in a particular learning and teaching process, or by the system. Examples of these properties are variables such as prior knowledge and learning style. These are set at runtime. Within so called ‘conditions’, rules can be written down for hiding and showing components based on individual property values.

### 4.2 XML-binding

Requirements for formalization, medium neutrality and interoperability have led to the decision to implement EML as an XML-application (Bray, Paoli, Sperberg-McQueen, Maler, & Yergeau, 1997). XML (Extensible Markup Language) is a general accepted meta-language for the structured description of documents and data, based on the ISO-standard SGML (Standard Generalized Markup Language).

Figure 2.2 shows the result of translating the conceptual ideas behind EML into an XML document type definition (DTD). This DTD serves as a kind of format to which all EML-documents must conform. The figure shows the hierarchy of the unit of study. According to this structure each EML-document representing a unit of study should at least consist of metadata (general descriptive information), a role definition, and a method section. ‘Content’ covers activity descriptions and environment specifications, including all kinds of objects that may exist within the environment. A full overview of EML elements and attributes is available through the EML reference manual (Hermans et al., 2000).

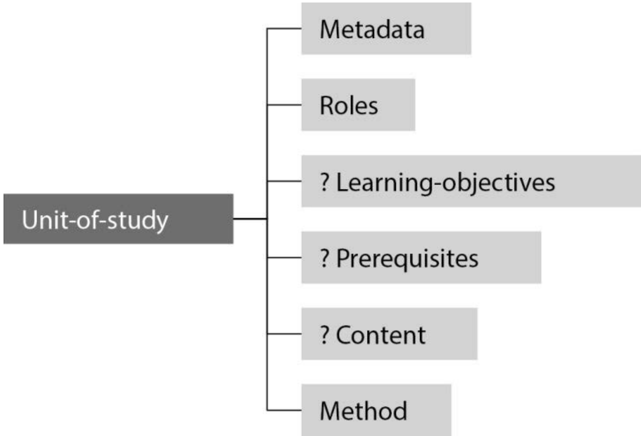


**Figure 2.2.** Basic structure EML binding

## 5 Designing within EML

Central starting point in creating a pedagogical design is the student who wants to learn. In order to attain the objectives of a unit of study students have to respond to the stimuli (that is, the activities) presented in the learning environment. The learning path and support environment reflect the pedagogical principles that have been advocated. In this way, EML is not pedagogically prescriptive, but enables one to implement one's own pedagogical choices.

This paragraph describes the steps that have to be followed in order to implement a pedagogical design in EML. Several EML code-examples will be provided to illustrate these steps. For delivery purposes, an EML player was developed (Edubox). This system is able to import EML-documents and publish them a personalized way.

### 5.1 Roles

The first step in preparing a design for EML is to specify which actors play a role in the instructional design. Here, a distinction has to be made between student roles and (supporting) staff roles such as tutor, instructor, or teacher (Figure 2.3). Which roles should be present in the EML-design depends on the pedagogical model applied.

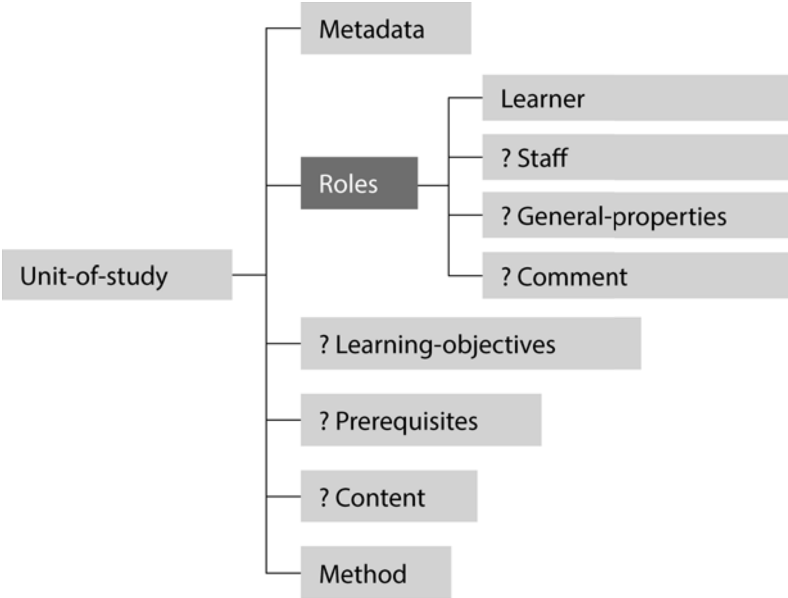


**Figure 2.3.** EML role specification

EML example 1 shows role declaration within EML. This example has been derived from a problem-based learning model and states that along with the role student there is a specific sub role ‘chair’, which has specific responsibilities within this instruction model. In addition to these two learner roles there is also a staff role, ‘tutor’.

```
<Roles>
    <Learner Id = "Student">
        <Role Id = "Chair"/>
    </Learner>
    <Staff Id = "Tutor"/>
</Roles>
```

**EML example 1.** Role declaration

## 5.2 Activities

The second step in the design is to specify what people in these roles are supposed to do, or in terms of EML which ‘activities’ they should perform (see Figure 2.4). There are two kinds of activities that can be distinguished: learning activities (to be performed by student roles), and support activities (to be conducted by either staff roles or student roles). For example, in the case of peer assessment these support activities are typically reserved for students. The nature of the learning activities depends on the pedagogical model used and may, for example, take the form of analysing problems, searching through literature, creating assignments or taking tests. Typical examples of staff activities consist of assessing students, providing feedback, monitoring, answering questions and so forth.

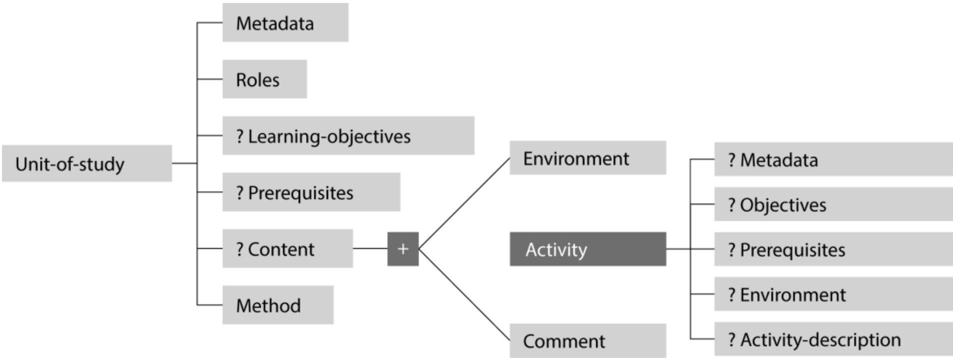


**Figure 2.4.** EML activity specification

In EML example 2, a learning activity has been briefly elaborated. Typical parts of a (learning) activity are the 'metadata', the (learning) 'objectives', the actual instruction, a description of how the activity is to be carried out, and the condition under which an activity is to be considered completed. In this particular example, the completion is set to 'User-choice' (line 23), meaning that the user can decide him/herself (for example, by clicking a check box) when the activity is completed. Completion rules play an essential part in workflow modelling. If explicit rules are stated, the workflow within a course or curriculum can be supported or even fully managed by the EML player.

### 5.3 Environment

As was stated earlier in this chapter, a (learning) activity is not performed in a vacuum, but takes place in a specific setting or context, which is referred to as the activity's 'environment'. Thus the next step in the design is to indicate which resources, tools and services an environment should contain in order to support the student or staff activity. Resources may consist of included or referenced learning materials like books, articles, cases or references. Tools and services cover objects like search engines, glossaries, portfolios, e-mail services or computer conferences.

```
<Activity Id = "a-conflict">
    <Metadata>
        <Title>Identifying an intercultural conflict on the workplace.</Title>
    </Metadata>
    <Learning-objectives>
        <Learning-objective Id = “LO-1">
            <Objective-description>
                <P>After completing this activity you are able to describe and
                analyse a conflict situation.</P>
            </Objective-description>
            <Objective-type><Skill></Objective-type>
        </Learning-objective>
    </Learning-objectives>
    <Activity-description>
        <What>
            <P>In order to have sufficient and realistic material to analyse, you
            will first need to …</P>
        </What>
        <How>
            <P>Describe the conflict at surface level, ie...</P>
        </How>
    </Activity-description>
    <Completed><User-choice/></Completed>
</Activity>
```

**EML example 2.** Activity specification

A specific rendering of an environment specification by the Edubox player is shown in Figure 2.5. The area on the left shows a tree-structure with branches representing the environment structure applied in the EML document, and leafs representing particular learning objects, tools or services.

### 5.4 Method

Specifying the roles, activities, and environments provides the building blocks for creating one or more learning paths throughout a course or curriculum. The next design step is to specify how activities are related, what the learning path looks like and how it can be adapted. EML’s ‘method’ section (see Figure 2.6) was designed for these purposes.

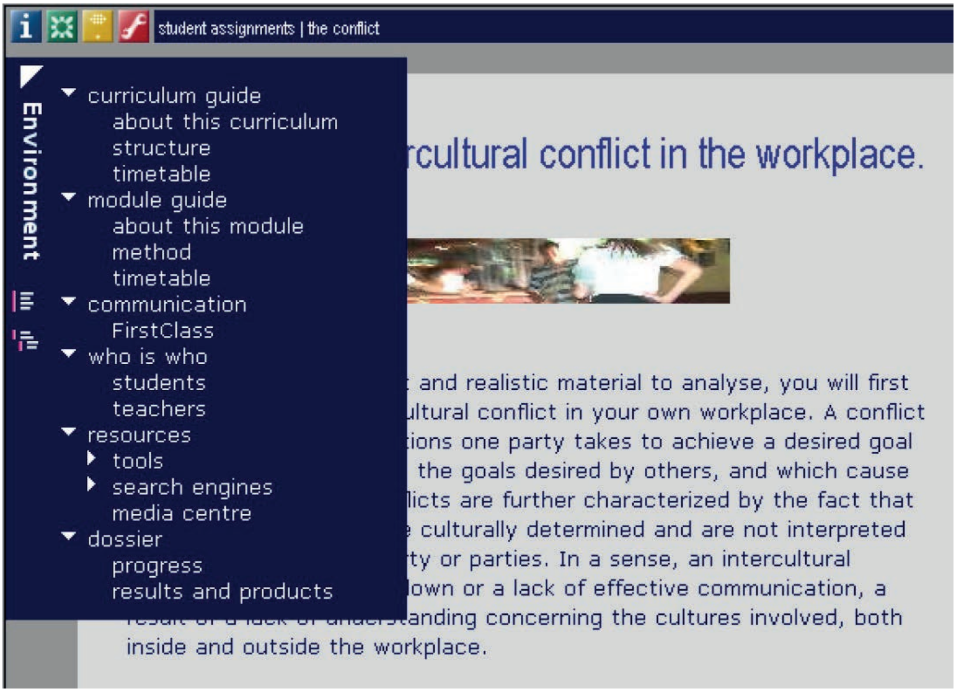


**Figure 2.5.** Environment representation in the Edubox player

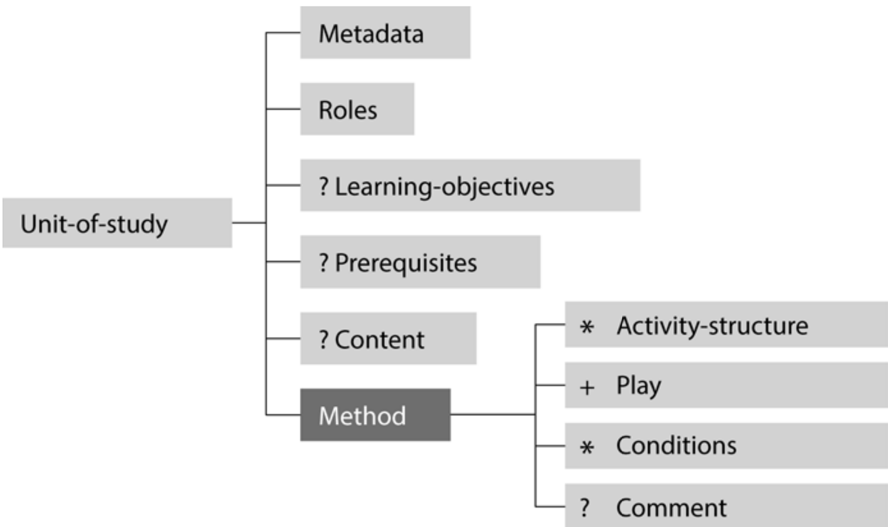


**Figure 2.6.** EML Method specification

First, relationships between activities can be specified through ‘activity-structures’. Within these structures, activities can be grouped and put either in a fixed order (‘sequence’) or free order (‘selection’). EML example 3 provides an activity structure with a fixed order, called ‘Student tasks’. This structure contains five learning activities (lines 5-10), which are to be performed sequentially. Note that as a consequence of modelling a sequence, an activity will only become accessible when the preceding activity has been completed. This provides an example of how workflow can be modelled.

```
1  <Method>
2      <Activity-structure Id = "AS-student">
3          <Activity-sequence Link-name = "Student tasks">
4              <Environment-ref Id-ref = “Support-environment"/>
5              <Activity-ref Id-ref = "A-Introduction">
6              <Activity-ref Id-ref = "A-Conflict">
7              <Activity-ref Id-ref = "A-Theory">
8              <Activity-ref Id-ref = "A-Analysis">
9              <Activity-ref Id-ref = "A-Memo">
10         </Activity-sequence>
11     </Activity-structure>
12 </Method>
```

**EML example 3.** Sequencing

Second, the educational script or scenario throughout a unit of study is to be specified in the ‘play’ section of an EML-document. Here, activities, activity structures or even complete units of study can be assigned to specified roles.

```
<Method>
    <Conditions Id = “Chair-conditions">
        <If>
            <Is><Role-ref Id-ref = “Chair”/></Is>
        </If>
        <Then>
            <Show><Content-type Type = “only-for-chair”/>
            <Activity-structure-ref Id-ref=“AS-chair”/></Show>
        </Then>
        <Else>
            <Hide><Content-type Type = “only-for-chair”/>
            <Activity-structure-ref Id-ref=“AS-chair”/></Hide>
        </Else>
    </Conditions>
</Method>
```

**EML example 4.** Conditions

The third part of the method section, called ‘conditions’, serves to specify how (parts of) the learning path can be adapted or personalized to students’ characteristics. EML example 4 is derived from a problem-solving model in which there is a specific student role called ‘Chair’. Persons in this role are supposed to carry out specific activities (line 8) while working in groups, and are provided with content (e.g. learning objects) that has been labelled as “only-for-chair” (line 7).

## 6 Evaluation

Of course, the proof of the pudding is in the eating. The requirements stated earlier in this chapter, and the pedagogical meta-model have resulted in the EML version as described and illustrated before. We should now like to review how some of the major requirements have been met in this version of EML.

As illustrated by the examples, EML is capable of expressing an instructional design in a formalized way (requirement 1) with a focus on semantics rather than on technical aspects (requirement 3). This statement is supported by the fact that Edubox is able to interpret various EML-documents and deliver units of study personalized to participants involved in the learning and teaching process. Moreover, the choice to implement EML as an XML binding meets demands of interoperability, compatibility and medium neutrality.

The extent to which EML appears to be suitable for expressing divergent pedagogical models (requirement 2) is of particular interest. Several laboratory tests were performed with EML followed by successful implementations in a variety of educational settings.

A major application of EML was located within the context of higher vocational education, where a hotel management school implemented a new model for competency-based learning. Nearly all modules within the institution’s dual mode curriculum were developed using EML, and were delivered using the Edubox player. EML components such as ‘activity’ and ‘environment’ appeared to be strong and useful concepts for modelling learning tasks.

At university level, EML had been tested within the OUNL as well as within the Digital University (DU), a (former) Dutch consortium of universities and institutes for higher vocational education. Within this consortium, institutes closely cooperated to create reusable learning materials. As most of these institutes had different e-learning platforms, there was a strong focus upon interoperability, reusability and use of open standards with respect to learning materials. EML appeared to be well suited in this context.

Within the OUNL, several pilot projects were initiated within different faculties. Courses with a variety of instructional designs were implemented in EML. Outside the OUNL, another application area was found in the field of in-company training. A new model for training call centre employees at a major pension fund was implemented using EML, which turned out to be a powerful technology in the innovation process.

## 7 Further developments

This chapter has provided a detailed description of EML and its underlying requirements. A lot of practical experience was gained using EML in an increasing number of courses and settings. Although this might satisfy the desire for a pedagogically flexible language, interoperability was limited to the scope of the OUNL and several partners, who were closely involved in the development of EML.

It was decided that the best way to proceed with EML was to get the specification accepted by a group of key players (end users, vendors, purchasers and managers), thereby creating a *de facto* standard (Hodgins et al., 2002). Formal standardization would then be the secondary and final long-term aim. An important group of key players with sufficient influence have been organized in the IMS Global Learning Consortium. The IMS Learning Design working group selected EML as a starting point for the development of the IMS Learning Design specification. Version 1 Final Specification was approved by the IMS Technical Advisory Board in February 2003 (IMS Global Learning Consortium, 2003). A major difference between EML and the IMS Learning Design specification is the integration of existing IMS specifications in the latter. However, at conceptual level EML and IMS Learning Design still align.

## 8 Retrospective

Since its publication in 2003, substantive research and development efforts have resulted in a varied set of tools and publications (e.g. Arpetti, Baranauskas, & Leo, 2013a, 2013b; Berggren et al., 2005; Burgos, Via, Juan, & Rioja, 2010; Dalziel, 2003; Derntl, Neumann, Griffiths, & Oberhuemer, 2012; García-Robles, Ferrer, & Cagigas, 2008; Hernández-leo et al., 2006; Katsamani & Retalis, 2011; Koper, 2006a; Martinez-Ortiz, Sierra, & Fernandez-Manjon, 2009; McAndrew, Goodyear, & Dalziel, 2006; Neumann et al., 2009), including efforts at the OUNL (e.g. Koper & Tattersall, 2005; Burgos, Tattersall, & Koper, 2007). However, the use of IMS LD turned out to be too ambitious for the OUNL in the years following. Hampered by the lack of user-friendly authoring tools and a poor functioning third-party LD player, IMS LD didn’t reach a large-scale application. Eventually, the OUNL’s existing e-learning infrastructure – including its IMS LD tools - was replaced by a commercial VLE.

Although the OUNL stopped using these first generation tools in its teaching and learning practice, it continued research and development on IMS LD, in particular within the European UNFOLD project (Burgos & Griffiths, 2005) and TENCompetence project (Koper & Specht, 2007). Chapter 4 of this thesis highlights how we, to support flexible delivery of courses to various learner target groups, created a new authoring approach based on the concepts of IMS LD and overcoming important drawbacks of IMS LD tools.

# Chapter 3

# Toward a learner-centred system for adult learning

This chapter has been published as: Hermans, H., Kalz, M., & Koper, R. (2014). Toward a learner-centred system for adult learning. *Campus-Wide Information Systems*, *31*(1), 2–13.

## Abstract

The Open University of the Netherlands (OUNL) provides bachelor and master courses for adult learners using traditional distance teaching methods and tools. One of the major problems encountered using classical distance teaching methods are the relatively high dropout rates. An analysis showed that this is partly due to a lack of fit to some of the adult learners' characteristics and the lack of social binding experienced by students with peer students and teachers. The classical distance teaching model does not strongly include most of the social tools that exist today and provides a 'one size fits all' approach in its offering.

As the existing e-learning infrastructure of the OUNL is primarily rooted in the traditional, formal distance education paradigm, we were challenged to design and develop a new type of e-learning system that meets the demands of adult learners in initial as well as post-initial education. We therefore propose a model for learning that integrates the use of concepts of virtual learning environments (VLEs), personal learning environments (PLEs), and social network sites (SNSs). The model comprises and integrates three learning contexts for the adult learner: the formal, instructional context, the personal context for learning management, and the social peer context.

We developed and tested a new e-learning system, called OpenU, which implements this model. In this paper we present how the model has been implemented within the pilot field of Learning Sciences and Technologies.

# 1 Introduction

In 1984 the Open University of the Netherlands (OUNL) was established as an institute for open higher distance education for adult learners. Its major goals were to offer adult learners a second chance to higher education and to provide an alternative route to higher education in order to reduce the load on costly traditional, face-to-face education. To meet these requirements OUNL adopted a typical distance-teaching model with a high degree of freedom for its students. The dominant pedagogical model was that of guided self-study: steering and guidance were embedded within the study materials delivered to students, so that very limited interaction between teachers and learner was required. This model contrasts with modern social constructivism approaches emphasizing the importance of social interaction for the acquisition of knowledge and skills (Schunk, 2012).

The OUNL model has been stable over the years, although the internet revolution completely changed the technological instrumentation. As it is the case within most distance teaching universities as well as regular universities the e-learning infrastructure is built around a virtual learning environment (VLE) application and is extended by a collection of dedicated services.

One of the major problems encountered in classical distance-teaching models is the high student dropout. E-learning courses show a substantially higher dropout rate compared to on-campus courses (Levy, 2007). (Simpson, 2013) states that the fundamental weakness of distance education is its dropout rate. Also OUNL faced these dropout problems over the years. Internal analyses showed that at least two factors play an important role in this respect. First, there is an evident lack of binding between students and between students and staff, and little opportunity for academic and social integration (Tinto, 1975; Woodley, 2004). The OUNL infrastructure offers only limited social interaction possibilities, and there is a limited sense of an academic community.

Second, OUNL has a rather heterogeneous population with different needs, characteristics, and preferences. This heterogeneity is mainly reflected in prior education, age, living and working environment, available time to study, need for structure, and willingness to study with others (peers). This requires a differentiated, more personalized approach, which is not sufficiently tailored by the current teaching and learning model nor by the technological infrastructure.

Against the background of both major problems, i.e., the lack of a social context for learning and the need for a more personal, learner-centred approach, the OUNL was challenged to rethink its e-learning model, and the deployment of services needed to support this model. In this paper we present a model for an e-learning system that integrates the concepts of VLEs, social network sites (SNSs), and personal learning environments (PLEs), representing the contexts of formal learning, social learning, and personal learning. This model is an application of the learning networks model (Koper, 2009b) that was developed, implemented, and piloted within the European TENCompetence project (Koper & Specht, 2007; TENCompetence Foundation, 2009). The OUNL has implemented this model in a web-based portal system.

In the following section we will characterize the typical learning contexts that play a key role in the practice of the adult learner and have a look at current integration initiatives. Next, we will present an integrated model for learning and explain how it combines learning in the different contexts. In the following section we will highlight the OUNL's first implementation of this model, called OpenU, accompanied by some results of a first user evaluation.

## 2 Contexts for adult learning

Adult learning is determined by a mixture of contexts in which learning happens. A typical scenario in the daily life of an adult learner may look like this:

> *Audrey is a general practitioner with a full time job. This Monday, like every working day after patient consultations, she spends some time searching for information and communicating in dedicated medical networks to update her knowledge. She bookmarks and tags relevant URLs, collects articles in an online file system, and reads the latest updates through RSS feeds in her favourite mash up tool. For this afternoon she has saved time in her agenda to join a one-hour webinar. She spends the evening studying for her master's degree in psychology at a distance teaching university. She has to log in to the university's VLE, where she has access to her courses, assignments, and grades. Through the VLE's forum application, she can discuss topics with peer students and pose questions to her tutors.*

This user-story shows an example of an adult learner dealing with separate, digital contexts in order to reach different goals for her professional development. The goals in this case relate on the one hand to keeping up to date in the current profession and on the other hand moving toward a new position (by doing an MSc in Psychology). The digital contexts she uses are isolated and require the learner to remember multiple accounts. Learner data are fragmented throughout these contexts and interfaces for exchanging data will most likely be absent

In general we can classify the digital contexts in which adult learners act and interact into three types of technological environments: first, VLEs, offered and managed by educational institutes; second, PLEs, addressing a personal collection of tools to manage and organize learning; and third, SNSs, bottom-up organized networks that facilitate users to find peers for sharing knowledge and creating new knowledge. In the following we will briefly discuss these environments.

## 2.1 VLEs

VLEs, also referred to as a learning management systems (LMS) or course management systems, have become an almost indispensable part of the e-learning infrastructure of universities and colleges (Brown, 2010). VLEs are usually built around the "course" concept (Sclater, 2008), under control of faculties and teachers. They have been typically designed for formal instructional purposes and as such provide common features for content creation, communication, (formal) assessment, and administration (Dabbagh & Bannan-Ritland, 2005). Most of the current generation VLEs have opened up to integration of social media tools, like wiki and blogs.

## 2.2 PLEs

The concept of the PLE was originally introduced by Olivier & Liber (2001) as a response to the growing amount of institution-centric VLEs. From a conceptual perspective a PLE can be viewed as a single user's e-learning system, that is under user control, and that provides tools to keep track of learning, to collaborate, and to connect to other VLEs or PLEs (Van Harmelen, 2006). A PLE is "comprised of all the different tools we use in our everyday life for learning" (Attwell, 2007).Whereas VLEs primarily have been designed to support institutional processes PLEs take the individual's learning process as a starting point. This learning is continuing, not restricted to a single context, a single provider, a specific pedagogical approach, nor restricted to formal learning processes.

PLEs may take different shapes with regards to technology, applications, or architecture (van Harmelen, 2006). As such they should be viewed as an approach to learning rather than an application (Attwell, 2007). The way learners compose their PLEs depends on their digital habitat (Wenger, White, & Smith, 2009), a constitution of preferred technologies, tools, features, and configurations.

## 2.3 SNSs

SNSs like Facebook, YouTube, or LinkedIn daily attract a huge amount of people, who use these sites for work, leisure, or study. Boyd & Ellison (2008) define a social network basically as an online, web-based environment that allows individuals to construct a profile, to articulate the list of people they have some kind relationship with, and to view the list of connections of other users. Besides profiling services SNSs have increasingly incorporated:

- tools for managing communities;
- features for storage and sharing of artefacts (music, videos, documents, images, presentations, bookmarks, etc.);
- ways of organizing and filtering connections and artefacts, like tagging and rating;

- tools for monitoring what is going on in the network, that increasingly also try to collect and integrate user activities from other SNSs (tweets, blogs, videos); and
- tools for recommending users and artefacts.

Learning in SNSs has an informal character. There are no designed learning situations. Learning has merely the character of sharing knowledge (Koper & Specht, 2007), that can either be explicit or implicit (Nonaka, Toyama, & Konno, 2000). Explicit knowledge refers to knowledge available through artefacts like learning objects, articles, presentations, or bookmarks. Implicit or tacit knowledge is typically rooted in persons, and can be elicited for example, through conversations between people.

### 2.4 Integration initiatives

Recent literature mentions several projects and initiatives that seek to integrate the different learning contexts into one system. Casquero, Portillo, Ovelar, Benito, & Romo (2010) propose a conceptual architecture of an institutionalized PLE that merges the institutional and personal spheres or contexts in a single user interface making use of web services. They mention an experimental prototype being under development.

García-Peñalvo, Conde, & Alier (2011) discuss the state of the art regarding PLE-LMS integration, based on integration strategies proposed by Wilson, Sharples, & Griffiths (2008). They conclude that – based on the problems raised within each of the strategies – the integration between the LMS and the PLE is still far from being achieved. Instead they suggest a service-oriented architecture as a possible solution accompanied by a proof of concept. For the development of the integrated OUNL learning system, which started in 2009, we adopted the concept of learning networks (Koper, 2009a), that was developed, implemented, and piloted within the European TENCompetence project throughout a period of five years (2005-2009). This project aimed at “an integration of the different tools, perspectives, and learning environments in a common open source infrastructure, based on today’s standards on the level of knowledge resources, learning activities, competence development programmes and learning networks” (Koper & Specht, 2007).

## 3 A model for an integrated learning system

### 3.1 The concepts of learning networks

A learning network in its essence is a technology-supported community of people who are helping each other to better understand and handle certain events and concepts in work or life (Koper, 2009). It supports personal competence development by providing services that facilitate them to have ubiquitous access to and navigation through the network, enable to position oneself in terms of competences and knowledge, as well as to find peers and professionals who can help and support in answering questions.

Learning networks follow a user-centred, learner-controlled model of distributed learning (Koper et al., 2005). Although a major part of this learning may have an informal character, this does not exclude formal learning. For effective and efficient competence building a mixture of both formal and informal learning activities is required.

### 3.2 Requirements

For the envisioned integrated e-learning system, we stated the following requirements:

R1. The system must offer the learner integrated access to all services needed for learning.

R2. The system must provide the learner a personal context with tools for self-managed learning. This implies tools for:

- planning activities;
- searching for and connecting to peers;
- collecting, organizing, and sharing resources;
- knowledge creation and sharing;
- reflection;
- evaluation.

R3. The system must be able to provide the learner with an institutional as well as social context to facilitate formal and informal learning.

R4. The social context of the system must foster for social interactions between learners. This implies that the learner must be able to identify other users within the social context and connect to them.

R5. The system must be able to register social interactions and enable other users to view and access the artefacts resulting from these interactions.

R6. The institutional context of the system must provide the learner with all tools and resources for carrying out a unit of learning (e.g. a course or training program). This requires, of course, also a proper tool set for teachers, but is out of scope for this paper.

### 3.3 Conceptual model

The conceptual model is based on four axioms. Koper (2001) poses eight axioms as a base for a meta-model of learning. We have adapted and restricted the axioms as to their relevance for the underlying model as follows:

1. a person learns by (inter-)acting in/with the external world;
2. the real world can be considered to be composed of social and personal situations, which provide the context for (inter)actions (activities);
3. a context is a container for a collection of things, human beings, and tools in a specific relationship; and
4. learning can be considered as a change in behaviour or the capacity to behave in a given fashion (Schunk, 2012).

These axioms are neutral regarding type of learning goals, type of activities, or instructional strategy.

Figure 3.1 provides the key concepts and associations between these concepts in a UML class diagram. The model is rooted in the conceptual model of learning networks by (Koper, 2009a), but has been simplified and adapted emphasizing the integration perspective.

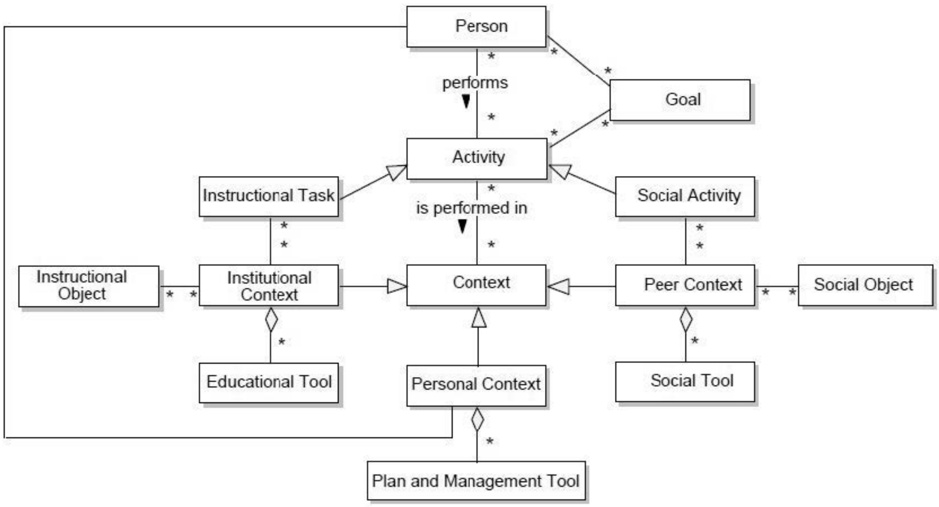


**Figure 3.1**. Conceptual model for learning in different contexts

The model starts with a person who has an implicitly or explicitly stated intention to learn (goal), e.g. do a MSc in psychology, explore the musical roots of your favourite artist, or keep update your knowledge about the use of tablet computers in education. To obtain these goals the person can carry out different activities, within an institutional context, within a social context, or within a mixture of both.

The peer context abstracts the social network context, enabling a person to interact in several roles – varying from novice to expert – with other persons (peers) that populate the social context. Activities in this context take the form of social interactions. The array of interaction types depends on the social tools that are present within the context. A social object refers to either an artefact being the registration of social interaction between two or more persons within the context or some type of artefact like a file or reference that a person shares within the context.

The institutional context reflects the formal, educational environment. The typical nature of activities in this context is that of carrying out instructions (instructional tasks) that have been designed by teachers or faculty staff in order to attain an explicit or implicit learning objective. The type of instructions and the way they are structured in a unit of learning, for example, a course, depend on the instructional model and educational philosophy of the educational provider. To enable and support learners in executing their tasks, the institutional context provides instructional objects, like assessments and resources, and educational tools like a virtual classroom, forum, or library service.

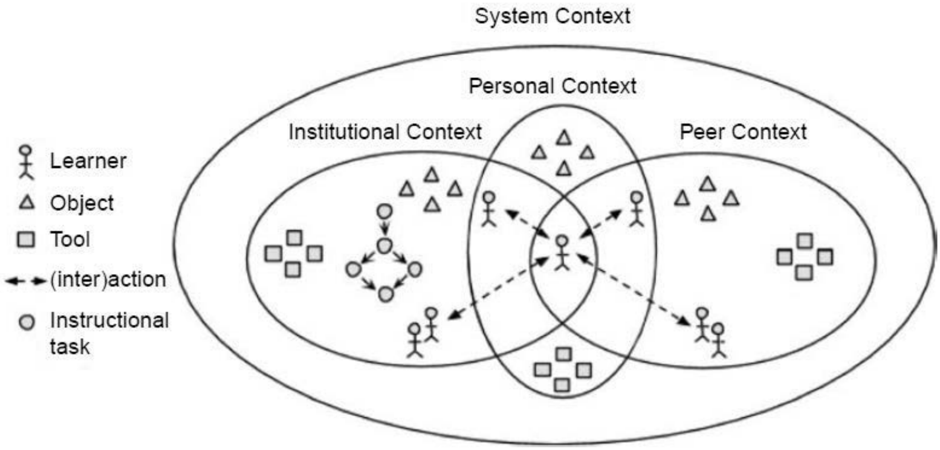


**Figure 3.2.** Integrated contexts for learning

The personal context is the layer that is under control of the person. This context comprises personal tools for management and planning of learning. It provides integral access to the institutional and peer context, and registers the (learning) activities undertaken in both contexts. Figure 3.2 illustrates how the different contexts can be connected in an integrated system.

# 4 Implementation of the model

## 4.1 OpenU

At the end of 2009 OUNL started building the OpenU system (http://openu.nl) as a new implementation of the integrated learning networks model as described before. The main differences between the OUNL and the previous TENCompetence implementations can be summarized as follows:

1. the OUNL implementation stresses an integrated, user-friendly solution, whereas the TENCompetence model mainly focussed on the functional perspective;
2. the OUNL implementation focuses on application in an institutional context, whereas the TENCompetence project aimed at lifelong learning in European countries in general;
3. the TENCompetence project aimed in particular at developing tools for informal learning, whereas the OUNL focusses on integration of both formal and informal learning services in one system.

Technically the OpenU system has been implemented on the open source java platform Liferay (Liferay, 2014). This platform provides a JSR 286 (The Java Community Process(SM) Program, 2008) compliant portal environment that allows for standardized integration of services. A high level of personalization is possible through an advanced role and permission system. The building blocks for web pages are portlets: small, configurable services. To meet the OUNL learning system requirements, a team of OUNL developers extended the available platform with portlets, for example, for course-related applications and user profile services (Sourceforge, 2014).

## 4.2 Implementation of digital contexts in OpenU

The model described in the previous section encompasses three digital contexts for learning. Figure 3.3 shows how these contexts were implemented in OpenU:

1. The personal context has been implemented through a personal workspace. Each person that registers gets a workspace, comprising a collection of web pages with services for activity planning (My Dashboard), profiling and connection (My Profile), social interaction (My Wall), reflection (My Blog), knowledge sharing (My Wiki), organizing and filtering resources (My Brats), and file storage and sharing (My Files). This context has been subject to a first user evaluation.
2. The institutional context, which offers units of learning like courses, online master-classes, or MOOCs, has been implemented as a collection of communities, how-ever, with typical services for formal learning. Providers may configure these communities according to their instructional design model and educational philosophy. Communities can have different access levels, ranging from free to full

access. Each access level focusses on a different group of learners and provides access to a tailored collection of instructions, resources, and services.

3. The peer context has to a large extent been integrated within both other contexts. A learner's personal workspace includes an extensive user profile and services to connect and interact with peers. The personal workspace also aggregates all the learner's social activities throughout the OpenU platform. This activity stream can be accessed and explored by peers.

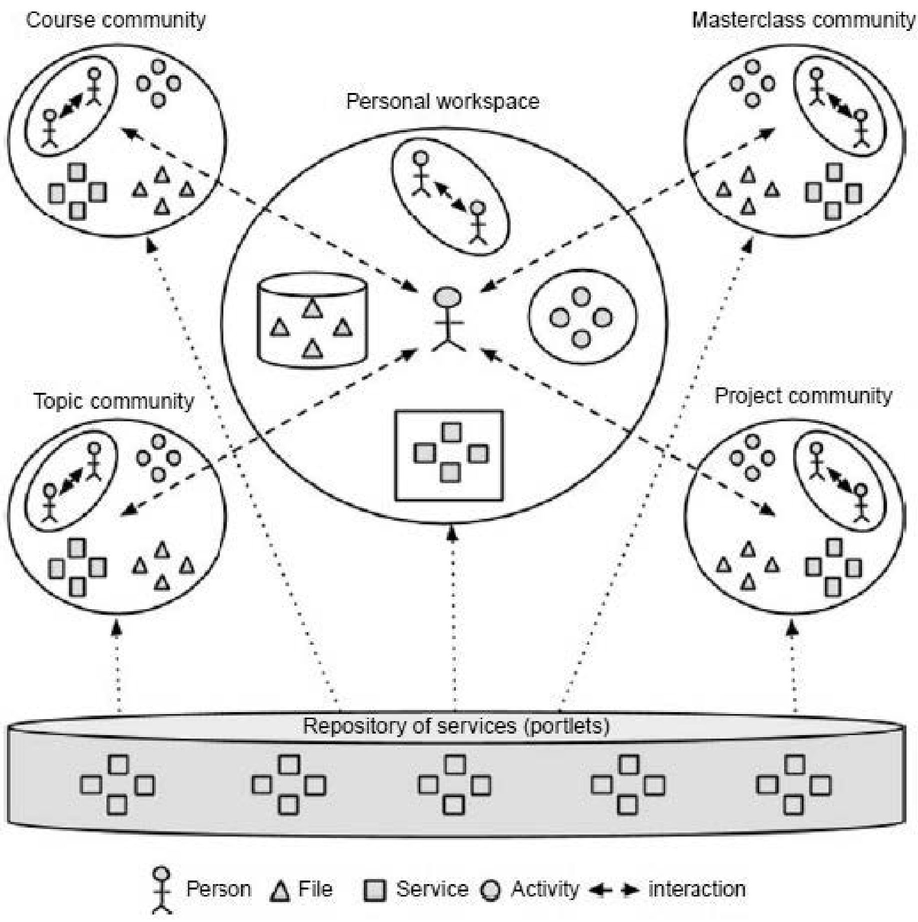


**Figure 3.3.** Learning contexts in OpenU

### 4.3 Pilot: Learning Sciences and Technologies

One of the first OpenU pilot areas is the domain of Learning Sciences and Technologies. Within this domain all courses that make up the OUNL's MSc in Learning Sciences were redesigned for flexible delivery in OpenU, and new educational formats were developed to meet the demands of the adult learner seeking for different learning opportunities.

All courses that make up the OUNL's MSc in Learning Sciences were redesigned and were implemented as course communities, providing access to different learner groups by using course access levels. A course access level determines which instructional activities, resources, and course and/or social services are accessible. After expiration of a registration period, learners remain member of the course community, although their access levels may be downgraded.

Courses contain tools like a group wall, a course blog, and a virtual classroom. Members' profile information is embedded and linked to personal workspaces. Activity streams allow members to view and explore social interactions within the course community.

Besides course communities, the following formats were designed and implemented in the pilot area:

- domain portals that summarize trends, research, and events within a domain;
- topic communities that make specific research areas accessible to a larger public;
- online masterclasses, an internet video-based format through which experts and audience discuss trending research topics;
- online lectures;
- learning tracks, subscription systems allowing learners – through a voucher system – to make a personal selection out of an extensive range of available courses within a domain (see chapter 5); and
- open educational resources.

### 4.4 First evaluation

A survey among members registered within the Learning Sciences and Technologies domain (*n*=3,470) focussed on use and appreciation of users' personal workspaces. An example of an OpenU personal workspace is shown in Figure 3.4.

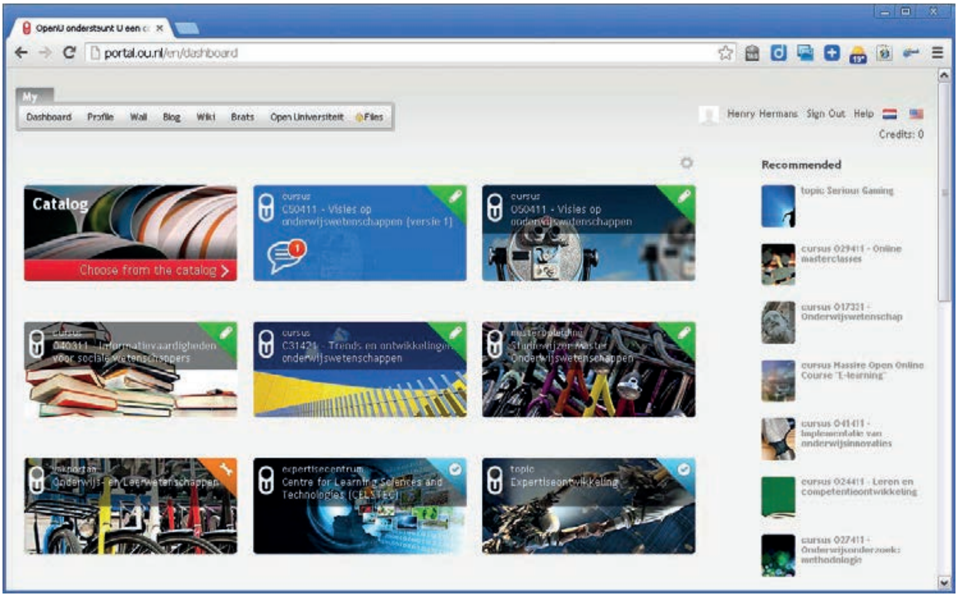


**Figure 3.4.** OpenU personal workspace – Dashboard

From the 252 respondents 66 percent reported to make use of their personal workspaces. Table 3.1 shows an overview of the usage and perceived ease of use of the services that make up the personal workspace.

**Table 3.1:** Usage and ease of use of personal workspace services

| Service | Number of respondents using the service | | Ease of use (mean score)* |
|---|---|---|---|
| | Abs. | % | |
| My Dashboard | 157 | 94 | 3,54 |
| My Profile | 151 | 90 | 3,53 |
| My Wall | **27** | **16** | 3,41 |
| My Blog | **34** | **20** | 4,03 |
| My Wiki | **2** | **1** | 3,50 |
| My Brats | **5** | **3** | 3,50 |
| My Files | **60** | **36** | 3,55 |

* *n*=167. Scale 1-5 (very complicated - very easy)

Most frequently used services within the group of respondents are My Dashboard (94 percent) and My Profile (90 percent). Least used services within the users’ personal workspaces are Brats, i.e. a collection of services (bookmarking, rating, annotating, tagging, and sharing) for organizing and filtering resources, and the wiki.

## 5 Discussion

In this paper we have introduced a model of an e-learning system that integrates the concepts of VLE, PLE, and SNS for the adult learner. It puts the learner in control of his/her learning supported by a personal context (personalized workspace) for managing the learning process. From within this personal context, a learner can access the institutional as well as the (social) peer context, thus providing the learner the possibility to mix formal as well as informal learning activities in order to achieve pursued learning objectives. The model is rooted in the learning networks concept that was elaborated, implemented, and tested in the European TENCompetence project.

In the OUNL's implementation of the model we were able to satisfy the requirements we stated for an integrated e-learning system. The personal, instructional, and peer contexts were integrated in a web-based portal system and piloted within the area of Learning Sciences and Technologies. A first evaluation of users' personal workspaces shows a broad variety in use of services. Whereas the personal dashboard and user profile service show a high usage level, the wiki service and services for collecting and filtering resources are hardly used. A possible explanation for the low usage of services may be the fact that these services are nowhere embedded in the institutional context (courses). The functionality within the learning process may be insufficiently clear. An alternative explanation might be that users lack the required knowledge management skills and for this reason instruction and training is required (Dabbagh & Kitsantas, 2012).

It is evident that the proposed integrated approach also strongly effects the way teachers design, develop, and run their courses. The teacher perspective was out of scope for this paper, but will be addressed in future research[3].

Finally, it should be noted that OpenU is still in a start-up phase. At the time of writing this paper OUNL is examining how to migrate the OpenU system to its central infrastructure. A key question that still has to be answered is how the system will affect OUNL's dropout rates.

[3] This subject is addressed in Chapter 4 of this thesis.

# Chapter 4

# Flexible authoring and delivery of online courses using IMS LD

Hermans, H., Janssen, J., Koper, R. (in press). Flexible authoring and delivery of online courses using IMS LD. *Interactive Learning Environments*.
DOI:10.1080/10494820.2014.994220

## Abstract

Since the publication of the IMS Learning Design (IMS LD) specification in 2003 many initiatives have been undertaken to build authoring tools that are simple enough to be used by non-technical instructors and teachers. IMS LD's technical complexity is believed to be a major burden for the adoption of the specification. We have developed a new approach for course authoring and delivery that hides most of the complexities and is powerful enough to create highly flexible online courses.

Key aspects in this approach are (1) integration of IMS LD authoring and delivery tools in order to enable teachers to adapt courses in runtime, (2) the use of templates to standardize aspects of the learning design. This article reports on the research and development of this approach, as well as a first implementation by the Open University of the Netherlands as part of an integrated e-learning system.

# 1 Introduction

In 2003 the IMS Global Learning Consortium published the Learning Design Specification with the objective "to provide a containment framework of elements that can describe any design of a teaching-learning process in a formal way" (IMS Global Learning Consortium, 2003). To this end the specification provides a conceptual model, based on a meta-model of learning (Koper, 2001), a detailed information model and an xml binding. McAndrew et al. (2006) point out that even at the simplest level (level A) IMS Learning Design (IMS LD) has the power to describe complex collaborative tasks with multiple roles and tools. Although the specification was conceived as very powerful considering its pedagogical expressiveness (e.g. Derntl et al., 2012; Van Es & Koper, 2006), it did not reach a high level of adoption, due to its perceived complexity of authoring and authoring tools.

The introduction of a new business model for distance learning and the resulting need for a different, non-traditional learning system, posed the Open University of the Netherlands (OUNL) with the challenge to create a flexible approach to authoring and delivery of online courses, taking the IMS LD authoring issues into consideration. This article presents the design and first implementation of this authoring and delivery system.

# 2 A new business model and implications for authoring and delivery

The Open University of the Netherlands (OUNL) is a distance teaching university that offers open higher distance education. In 2008 an internal task force outlined a new strategy for the delivery of education originating from the ambition to give open educational resources (OER) and lifelong learning a sound position. The main goals stated within this new strategy can be summarized as:

1. attract new target groups through renewal of educational offerings;
2. promote retention;
3. support more efficient course development; and
4. enhance visibility of the OUNL, as both as a research and an educational institution.

The new model that was developed as a result of this strategy is depicted in Figure 4.1. Koper (2014) characterizes this model as a 'concentric circles model', dividing the target population into several groups, which are offered tailored course types such as MSc courses, online masterclasses or MOOCs, and tailored services, such as discussion boards, assessment or tutoring. For the sake of readability, the various course types will all be referred to as "online courses". The concentric circles model follows an incremental approach, meaning that the collection of available online courses and services increases when moving from the outer circle to the inner circle of the model.

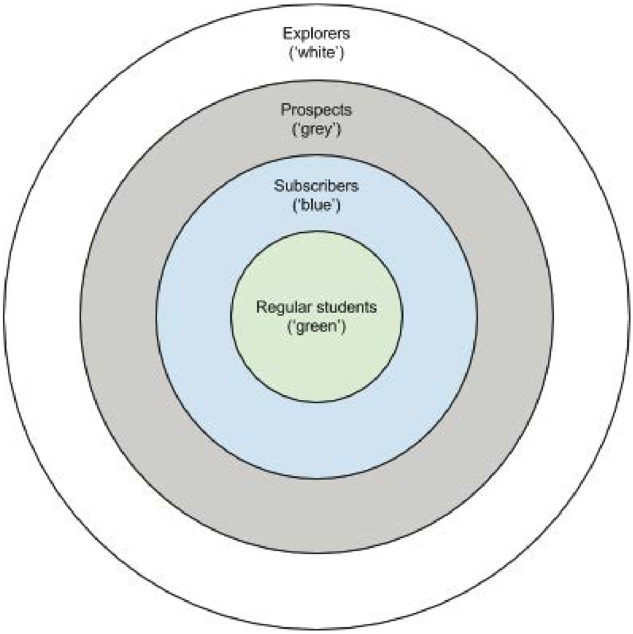


**Figure 4.1.** Concentric circles model

Each circle reflects a different, colour coded learner target group, with its own main learning interest (Table 4.1).

**Table 4.1.** Target groups and main interests

| Target group | Colour | Main interests |
|---|---|---|
| Regular students | Green | BSc or MSc courses, PhD programmes |
| Subscribers | Blue | Post-initial, continuing education |
| Prospects | Grey | OUNL offerings |
| Explorers | White | OER |

In the period 2009-2013, this model was elaborated and implemented within the domain of Learning Sciences and Technologies, comprising an MSc programme, post-initial education and a research programme. Implementation of the model meant designing and implementing a new technological infrastructure (Vogten & Koper, 2014), as it was clear from the beginning that the OUNL's existing infrastructure was inadequate for the delivery of full online courses, since it was based on a traditional, commercial virtual learning environment (VLE), with its origins in more traditional, on campus learning and teaching approaches. The new e-learning system was founded on the concept of learning networks (Koper, 2009b): a technology supported community of people in a particular discipline who are helping each other to better understand and handle certain events and concepts in work or life.

The e-learning system aimed at improving the learner's user experience and accessibility by integrating formal learning, social learning and personal learning into one system (Hermans, Kalz, & Koper, 2014). Moreover, from a business point of view it was much more efficient to serve different target groups through one single system instead of maintaining a cluster of dedicated e-learning systems for separate learner groups. So both from a learner perspective and the institutional perspective, integration was a key requirement in the development of the new learning system.

The demands from the business model, along with the choice for IMS LD, led to the following general ´a priori´ requirements for the authoring and delivery system:

| | |
|---|---|
| R1. | The system must support flexible delivery of online course within BSc and MSc programmes, lifelong learning programmes, or as open educational resources. |
| R2. | The system must be compliant to IMS LD's conceptual model. This implies that all components must relate to and can be expressed according to the IMS LD conceptual model. |

No demands for interoperability support were formulated. More specific authoring related requirements will be identified in the next section, following a brief explanation of IMS LD and a discussion of IMS LD authoring and publishing issues.

## 3 Learning Design authoring and delivery - state of the art

### 3.1 IMS Learning Design

The IMS LD specification has its origins in the Educational Modelling Language (EML) developed at the OUNL (Hermans et al., 2004[4]; Koper & Manderveld, 2004). The specification contains a *conceptual* model, providing instructional designers a common language to express and discuss their learning designs, as well as a detailed *information*

[4] This publication is included as Chapter 2 in this thesis.

model, a machine readable format for exchanging learning designs. The IMS LD specification holds three levels:

- Level A: includes the core elements to create learning designs with pedagogic diversity;
- Level B: extends Level A with properties and conditions; and
- Level C: extends Level B with notifications.

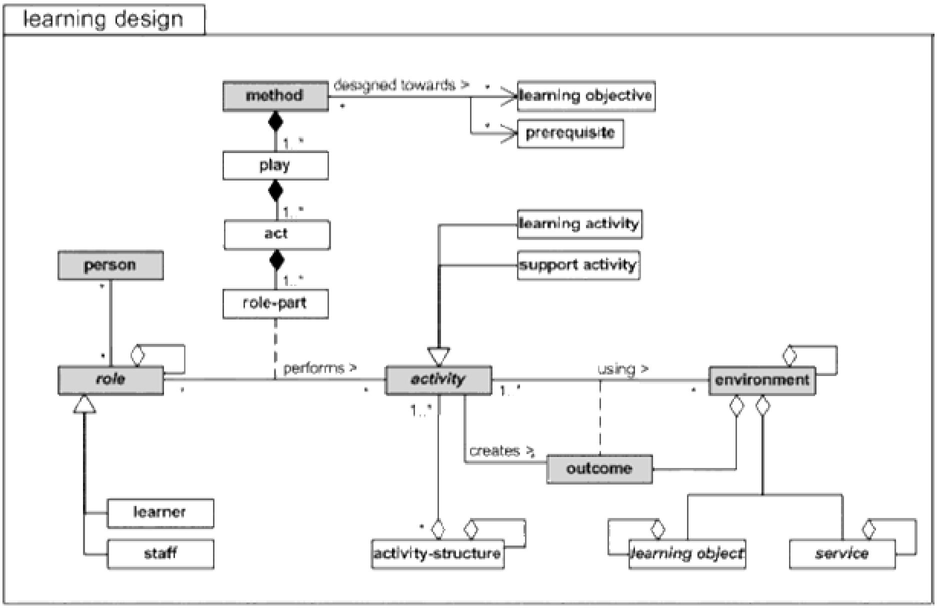


**Figure 4.2.** IMS Learning Design Level A: conceptual model
Source: http://www.imsglobal.org/learningdesign/ldv1p0/imsld_infov1p0.html

For a good understanding of the new approach to authoring and delivery of online courses we first summarize the key elements of IMS LD´s conceptual model that are marked grey in Figure 4.2.

- *person*: human being who can be involved in the learning and teaching process in one or more roles;
- *role*: specification of a learner or staff role in the learning design ;
- *activity*: planned learner or staff action; for learners the typical nature of activities is that of carrying out instructions whereas staff activities are aimed at supporting the learners in attaining the explicit or implicit learning objective(s);

- *environment*: container for wrapping a collection of learning objects and/or services;
- *method*: (work)flow within a learning design, expressed through concepts such as ‘play’, ‘act’ and ‘role-part’ in analogy to theatrical performances; and
- *outcome*: result of performing an activity within an environment.

A learning design that is to be run by computers is a *unit of learning*: a complete, self-contained unit of education such as a course, training, a lesson or a MOOC. A unit of learning is a package (zip file), including the learning design as well as the associated (physical) resources such as files, assessments, or references.

Overviews of state-of-the art learning design editors are provided by Arpetti et al. (2013b) and Katsamani & Retalis (2011). In discussing what they call the last generation tools, Arpetti et al. (2013b) state that these tools “have followed a trend away from the metaphor used by IMS LD in favour of representations that facilitate interpretation and understanding”. This statement reflects the ongoing struggle that has been present since IMS LD’s publication in 2003 on how to create efficient and usable learning design authoring and runtime tools. This struggle is expressed through debates (e.g. Martinez-Ortiz et al., 2009; Neumann & Oberhuemer, 2009) on questions such as the following:

- How do we represent IMS LD in a graphical user interface?
- How much IMS LD knowledge may we expect from instructional designers?
- Which IMS LD elements can we hide for authors?

The jumpstart issue in these discussions is the pursued level of adoption of the specification: modelling language, interoperability specification, infrastructure or methodology (Griffiths & Liber, 2008). Olivier & Tattersall (2005) state that learning design tools should provide higher-level representations. For instructional designers to carry out their tasks comes first and they should not be bothered by XML formats needed for interoperability. Authoring tools should follow the designer's perspective, distant from the specification (García-Robles et al., 2008). Full-fledged IMS LD authoring is complex, requiring knowledge of the specification in a technical way (Burgos et al., 2010) so authors may benefit from tools tailored to specific pedagogical models. Arpetti’s statement confirms that these principles are increasingly applied in current approaches. Drawing on this discussion the following authoring requirement was defined:

| | |
|---|---|
| R3. | The system must have a focused task orientation that demands no IMS LD knowledge from authors. |

### 3.2 LD publishing

Most IMS LD approaches use architectures with a strict separation between design time and runtime, making it hard, if not impossible, to preview and test a learning design in action in the runtime environment. In these architectures, the publication process is often complex, requiring several steps to get a course, developed in an IMS LD authoring tool, up and running in an IMS LD player.

IMS LD authoring discussions make clear that learning design tools should follow as much as possible the natural habitat of learning designers. Berggren et al. (2005) propose a 'bricolage' or ´design on the fly´ approach, an organic way of iterative design and refinement as opposed to the planned 'engineer' way. This implies that a learning design authoring tool should provide access to a runtime environment, thus allowing authors to preview their learning design at the current stage (Olivier, 2006), or even better, a learning design editor that is fully integrated in the runtime environment, enabling authors to 'design on the fly' and allowing them to adjust the learning design even in runtime (*runtime adaptation*). Based on this discussion we formulated the following authoring related requirements:

R4. The system must allow authors to adapt the learning design and contents of online courses in design time as well as in runtime.

R5. The system must allow authors to easily test and preview the learning design in the runtime environment.

To be clear, runtime adaptation in this article relates to manually adjusting the flow and content of the learning design. Other interpretations (Burgos et al., 2010; Rosmalen & Boticario, 2005) may relate to dynamically adapting the learning design by the runtime system, based on rules 'programmed' in the learning design. The latter type of adaptation requires the IMS level B conditions and properties mechanisms.

## 4 Design of the authoring and delivery system

The aforementioned requirements implied two main architecture principles for the system: (1) integration, following requirements R4 and R5, and (2) standardization, following requirements R1 and R3. How these principles help address these specific requirements will be elaborated in the following section.

## 4.1 Integration and standardization

Application of the principle of *integration* means joining the tools for the processes of designing, developing, publishing, and running an online course in one system, and allowing for easy transitions between these processes. In this way an instructional designer or author can easily 'move' between design time and runtime environment, and test, preview and adjust the learning design at any time. Additional advantages of integrating these tools and processes are (1) the user experience is improved by providing a consistent user interface and (2) the design process is simplified as the available services in the runtime environment are known, whereas in the absence of a runtime environment only abstract modelling of services is possible.

*Standardization* is a way to ensure the presence of required and proper configured components in the learning design and can be achieved by adopting a layered model as depicted in Figure 4.3. This layered model meets the (software) design principle of 'separation of concerns' (http://en.wikipedia.org/wiki/Separation_of_concerns), which aims at easier management of complex systems by encapsulating functions in layers that have a well-defined interface (see also Katsamani & Retalis, 2011). The top of the figure shows the type of constraints that may affect the learning design.

- Business constraints typically determine the range of learner target groups to be addressed in the learning design. In case of the OUNL the concentric circles model accounts for the learner roles needed.
- Pedagogical constraints result from the organization's or faculty's pedagogical framework for teaching and learning such as problem-based learning, competency-based learning, or game-based learning. These types of constraints are likely to influence all parts of the learning design (*roles, activities, environments and method*).
- The tools that are present in an institution's technological infrastructure determine the collection of *services* that can be addressed in the *environment*.

The first layer is the *template layer*, where an instructional designer can create templates for online courses. A template is the initial state of a course, containing all elements and pre-sets of the learning design required by the business and pedagogical model and constrained by services available in the infrastructure. Templates provide a means to standardize and control the learning design to the level needed. The second layer is the *course layer*, in which authors can develop online courses derived from and controlled by templates. Within these courses authors can edit the learning design according to the degree of freedom provided by the templates.

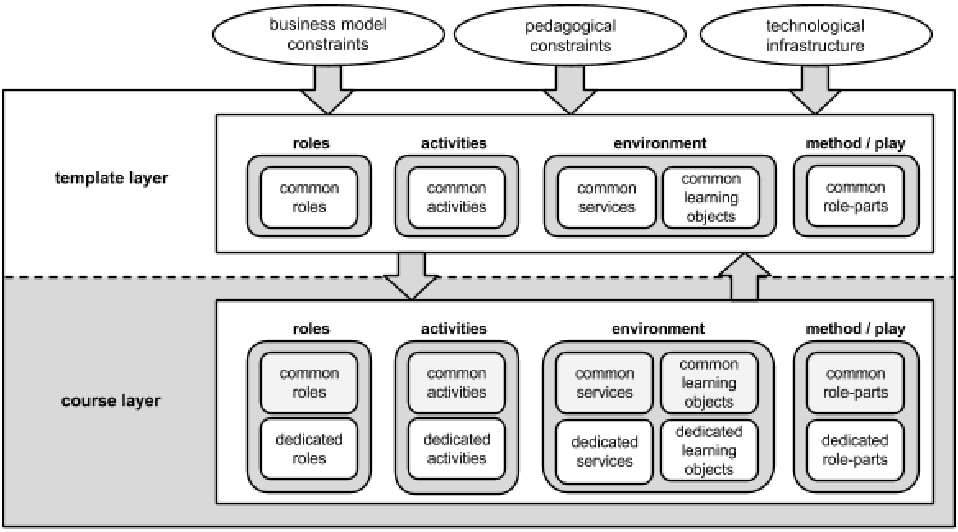


**Figure 4.3.** Layered learning design approach

# 5 OUNL implementation

This section describes how the requirements for flexible authoring and delivery have been met in a first implementation at the OUNL.

## 5.1 Platform

The OUNL has implemented the authoring and delivery system as part of a new, integrated e-learning system called OpenU (http://openu.nl), which is built on the community-based Liferay Portal platform (Liferay, 2014). This open source platform contains an advanced, customizable roles and permissions system, which was needed to be able to split up courses into configurations that could be flexibly delivered to the target learners groups from the business model (requirement R1). The service-oriented architecture of the portal allows for standardized integration of additional services. Through the portal's web interface these services are delivered as configurable portlets that can be arranged on web pages.

The platform's 'community' entity has been used as a container for design and delivery of online courses. In order to explain the implemented solution for the authoring and delivery system we first provide a simplified overview of Liferay's community structure, depicted in Figure 4.4.

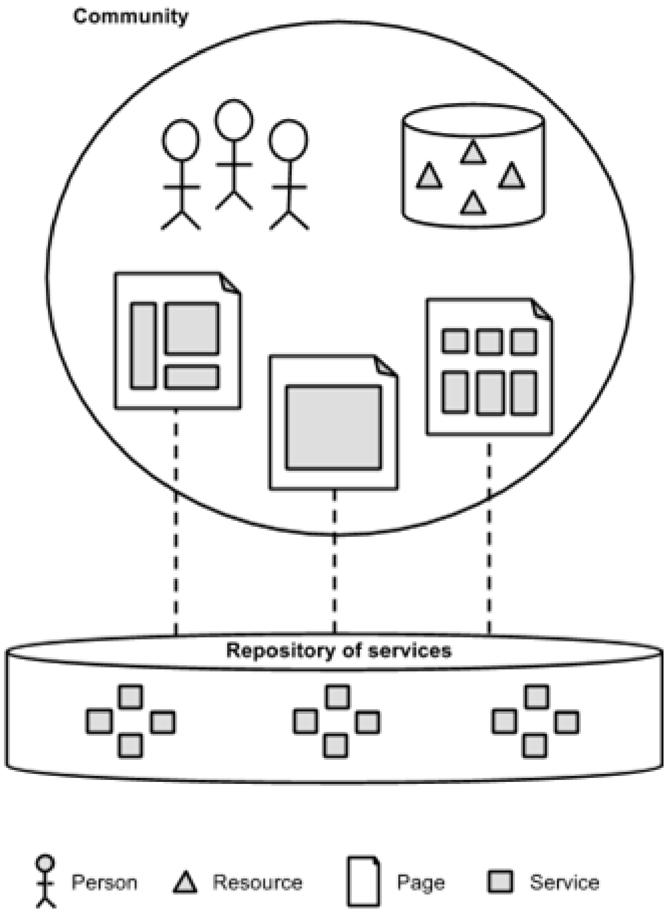


**Figure 4.4.** Platform community structure

A community is a grouping of users with common interests, web pages, services and resources. Each page has a layout, where configurable portlets can be added and arranged. A portlet is a user interface component, wrapping some service or application, such as a blog, wiki, or forum, and providing access to its functionality. Through configuration a portlet's display settings, permissions and preferences can be adjusted. Considering the requirement of flexible delivery (R1), it is important to stress that for each page, portlet and resource within a community, an extensible range of permissions can be granted to the roles in the learning design.

### 5.2 The OpenU authoring and delivery system

To standardize aspects of the learning design, templates were developed for two online course types. These templates were technically built as containers holding pages and resources that can be easily copied into a community. Functionally, the templates were developed as learning designs, containing standardized roles, activities, environments and role parts. Out-of-the-box available platform services, such as wiki, forum and RSS feed reader, were extended with, among other things, course services, for example for authoring and monitoring by a team of OUNL developers.

Each template contains both a design time environment and a runtime environment (Figure 4.5) that share resources. Both environments have been implemented as a collection of web pages with role-based access. The design time environment is composed of 'author pages' holding all the services needed for elaborating the learning design and managing resources such as assessments, documents and images. The runtime environment contains 'course pages', offering all services needed for executing the learning design such as learning design player, a virtual classroom and a student monitor. In addition, the runtime environment is split up in learner access levels, corresponding to the levels in the concentric circles model. When moving up to a higher level in the learner hierarchy, learners receive added value, such as access to all course resources (blue users) or assessments and tutoring services (green users).

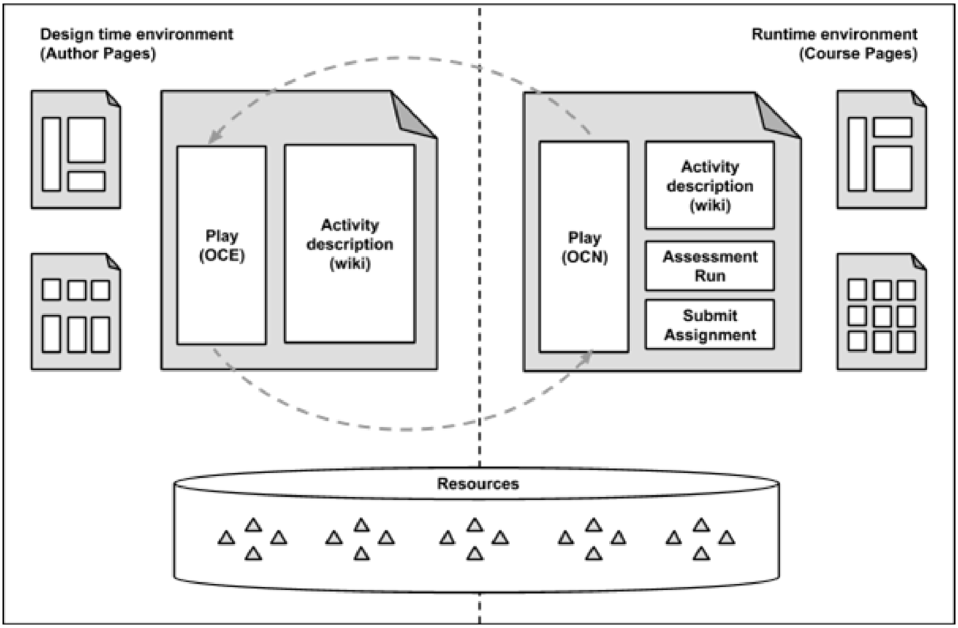


**Figure 4.5.** OpenU course template structure

### 5.2.1 OpenU Course Editor

Key service in the design time environment is the OpenU Course Editor (OCE) that has been developed by the OUNL's ICT developers for editing the learning design. It was developed as a specific purpose tool (see Griffiths, Blat, Garcia, Vogten, & Kwong, 2005), tailored to the requirements of the business model, requiring no IMS LD knowledge from its users. The editor supports all main constructs of IMS Learning Design level A.


**Figure 4.6.** OpenU Course Editor

The editor has a graphical, tree based user interface (see Figure 4.6), representing a learning design's *play*, containing branches (activity structures) and leaves (activities). The activity tree can be adapted by adding, moving or nesting learning or support activities. Each activity can be configured with respect to IMS LD elements such as activity completion and activity outcome. The platform's wiki service is used for editing the *activity description*. The use of the wiki ensures that the change history is kept and allows for co-authoring of activities. Besides, depending on the course's pedagogical model, students can be involved in authoring learning activities by granting them authoring access to the wiki.

A distinctive feature of the OCE, addressing the business model requirements and serving efficiency purposes, is colour scheme based activity assignment. Activities can simply be assigned to a specific learner target group by selecting the corresponding colour next to the activity title. Figure 4.7 shows an overview of colours corresponding to the learner target groups in the concentric circles model.

### 5.2.2 OpenU Course Navigator

The learning design, elaborated in the OCE, is interpreted and run by another service, the OpenU Course Navigator (OCN). This service is available in the runtime environment. It runs and personalizes the activity tree based on the user's (learner) role. Through the OCN's preview facility, authors can easily check the effects of their adjustments for each particular learner target group. The OCN is aware of modifications in the OCE, and instantly re-calculates the activity tree after a learning design has been updated. Changes in the activity tree as well as changes in content can be made at any time with no need for authors to republish the course. In this way the requirement of runtime adaptation could be addressed. The publication process has in fact been reduced to simply turning on learner subscription. The personalization process follows the incremental model of the concentric circles model. Stepping up the learner 'hierarchy', ranging from explorer (white user) to student (green user), the number of accessible learning activities increases (Figure 4.7).

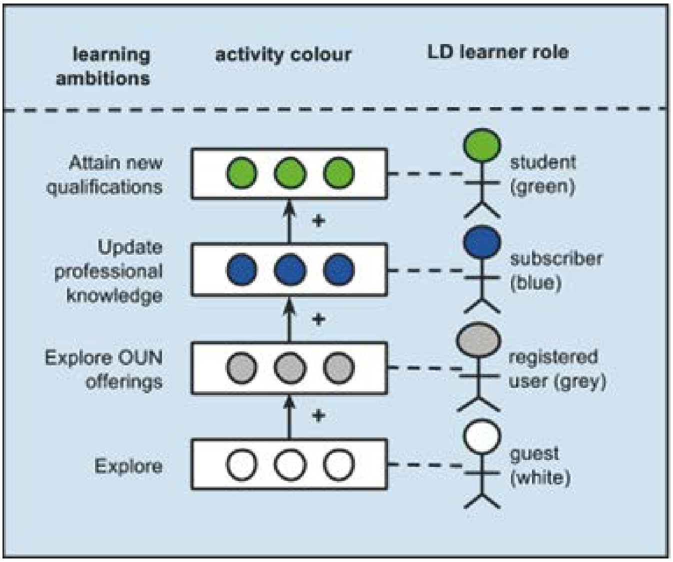


**Figure 4.7**. Learning activity colour scheme

Besides web delivery, the OCN also supports EPUB (International Digital Publishing Forum, 2014) and PDF ("PDF files" 2014) delivery. Both delivery types are optional, and have to be enabled in the OCE. When enabled, learners can download their personalized course, for example, for studying from print or some mobile device such as an e-reader. As the platform's internal storage format is based on XML (Bray et al., 1997), it has the potential to export the learning design to a range of formats.

## 5.3 System usage in the context of Learning Sciences and Technologies

The authoring and delivery system was adopted within the domain of Learning Sciences and Technologies. For each of the course types 'MSc course' and 'online masterclass' a template was developed in cooperation with faculty staff. An online masterclass is a newly developed course format, with a turnaround of one week, in which experts and learners discuss trending topics in a structured way, using synchronous and asynchronous services. The templates offered authors a considerable amount of freedom with respect to type of activities, the activity flow (play), and resources to be used. A basic, though extendable set of course tools (services) was used to assure a consistent user experience throughout the MSc courses as well as the online masterclasses. From May 2011 to February 2014, a total of 26 MSc courses (4,3 ECTS[5] each), 32 online masterclasses and 1 MOOC were developed and delivered using this system. Until February 2014, these online course communities have an average amount of 224 registered members (*n*=59) with a minimum of 23 and a maximum of 904 members. Kick-start for the development of the MSc courses was a one-week training and implementation session for the core authors in May 2011.

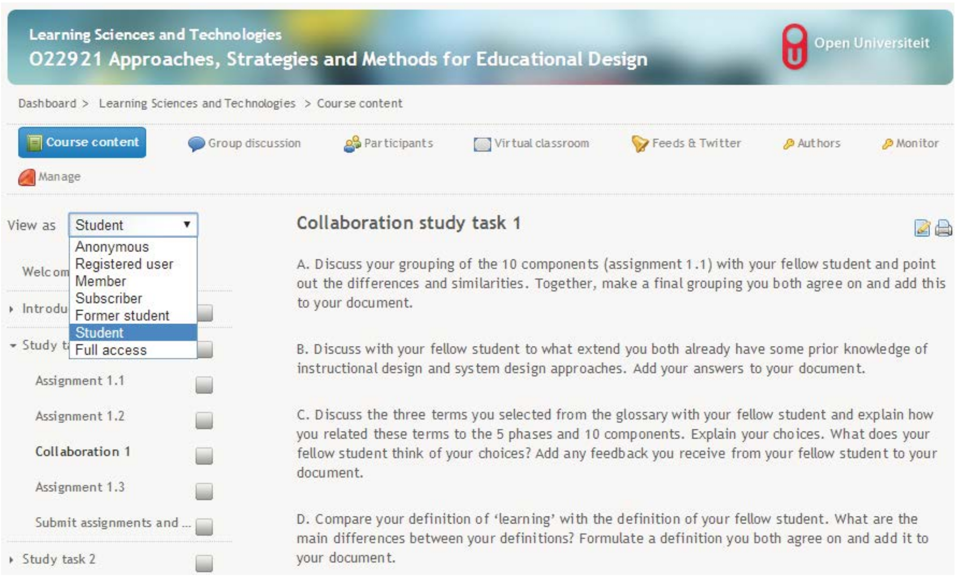


**Figure 4.8.** Learning design preview

A typical usage scenario for the authoring and delivery system looked as follows. First, a course was created based on one of the available course templates, containing the

[5] European Credit Transfer and Accumulation System (http://ec.europa.eu/education/tools/ects_en.htm).

initial learning design choices and restrictions, stemming from the business model and pedagogical choices agreed at the faculty level (requirement R3). Next, teachers who were instructed about the business model and faculty's pedagogical framework were assigned to the course as course *authors*, allowing them to access the author pages (design time environment) as well as the course pages (runtime environment). Using the OCE, and supported by typical assessment and document storage services, teachers could stepwise (co)author the course's learning design. At any time, teachers could simply switch from author pages to the course pages in order to preview and check the course for each targeted learner group in the OCN (requirement R5; see Figure 4.8). Any learning design adjustment could easily be applied through the OCE, regardless of a course's publication status (requirement R4).

### *5.3.1 Runtime adaptation*

The aim of this study was to present a new approach to IMS LD-based authoring and delivery within the context of a changing business model for distance education. The requirement for runtime adaptation (R4) aims in fact at offering authors more freedom, and as such implies increasing flexibility in how to develop their courses. To get an indication of authors' editing behaviours, we analysed each course's history with respect to modifications in wiki pages. As mentioned earlier, we used the courses' wikis to edit the contents of the learning design activities. By comparing the version dates of wiki pages with the course publication dates, we were able to pinpoint modifications as being made in design time or runtime. Figure 4.9 provides an accumulated overview of the percentage of learning design activities modified in design time, runtime or both.

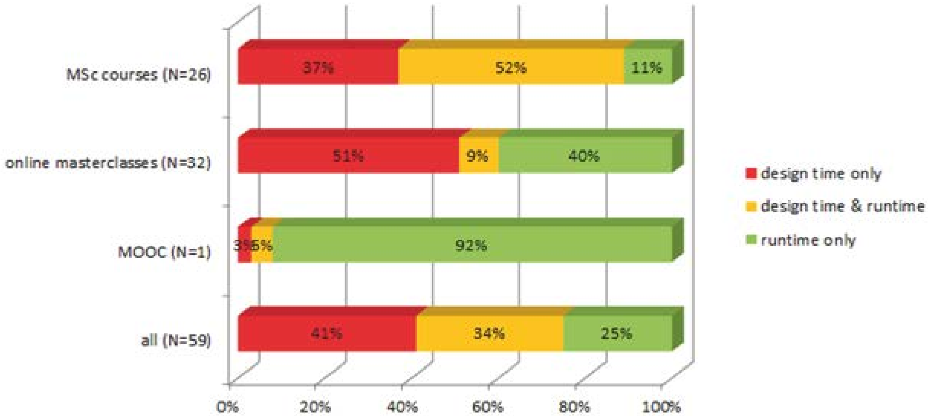


**Figure 4.9.** Distribution of learning design activities modified in design time and/or runtime

The overview provides further support to the requirement of runtime adaptation: 41% of all course activities have been created and/or modified in design time, whereas 59% have been modified or even created in runtime.

### *5.1.1 Flexible delivery*

Supporting the concentric model required the development of online courses that can be flexibly delivered to the identified learner target groups. To get an impression of how the various target groups actually have been addressed, all courses' activity trees (*n*=59) were examined with respect to the distribution of activities across the various target groups. Figure 4.10 presents the results for the different course types. The charts show the dominant presence of *subscriber* activities and a fairly small proportion of *student* activities within both course types. Noteworthy is the absence of *prospect* activities within the MSc courses.

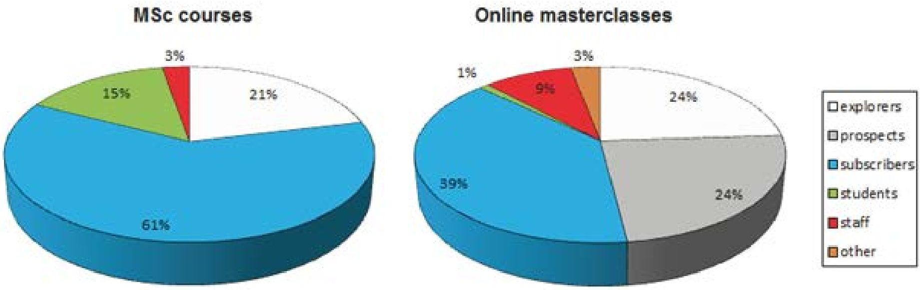


**Figure 4.10.** Distribution of learning design activities to learner target groups in the concentric circles model

## 6 Conclusions and discussion

In this article we have introduced a new approach to IMS LD based authoring and delivery of online courses to meet the demands of (1) flexible delivery, stemming from the OUNL´s changing business model for distance education, (2) IMS LD compliancy and (3) efficient IMS LD authoring, based on a reflection of the main IMS LD criticisms. Key aspects in this approach are integration of LD authoring in the runtime environment and the use of templates to standardize aspects of the learning design.

A first implementation of the approach was realized within a new, integrated e-learning system (OpenU) that the OUNL has built and used in the period 2009 – 2013, founded on the principles of learning networks. To support the advocated approach a specific purpose IMS LD editor and player were developed within a portal architecture that allows for seamless integration of tools and also provides the role and permissions system needed for flexible delivery (requirement R1).

The resulting authoring and delivery system was used within the domain of Learning Sciences and Technologies. Starting from May 2011 until February 2014 a total of 59 online courses, either MSc courses or online masterclasses, were developed and delivered using this system. Our implementation proves that it is possible to break down the walls between IMS LD authoring and delivery by integrating design time and runtime tools that are aware of each other, and thus allowing authors to easily switch between design time and runtime. The collected usage data confirm the need for runtime adaptation: 59% of all course activities have been modified or even created in runtime.

Flexible delivery of online courses to the learner target groups in the concentric circles model was achieved by creating course access layers, making use of the portal´s roles and permissions system. Moreover, applying these access layers enabled to implement additional business rules, for example learners enrolled as a student (green access level) in an MSc course automatically receive 'subscriber' access to all other MSc courses. Assembly and delivery of courses in this respect will be reported upon in a next study. Remarkably, our study revealed that ‘prospects’ (grey users) were not addressed in the MSc courses’ learning designs. As this constitutes an important target group in the OUNL’s strategy, further research is needed to understand why this is so.

Finally, a nuance has to be made with respect to runtime authoring, which reflects a limitation in our implementation so far. Runtime authoring requires mechanisms to assure that learners are notified of (small) changes and, in the case of major changes, a new version of the course is delivered for new cohorts of students. For example, adding a new learning activity to study task “A” may cause an update for each learner’s activity tree, although a learner may already have finished study task “A” or even fully completed the course. Learning design versioning will be needed to provide a proper solution to this issue.

# Chapter 5

# Flexible provisioning for adult learners

Hermans, H., Janssen, J., Vogten, H., Koper, R. (in press). *Flexible provisioning for adult learners*. Journal of Universal Computer Science.

## Abstract

In adult education there is a continuous, growing demand for learning opportunities that fit the specific characteristics and preferences of particular learner groups or individual learners. This requires educational institutions to rethink their business and educational models, and develop more flexible online course solutions using ICT. An important downside of this trend is an increasingly complex logistic process that is very difficult to manage, in particular with respect to the provisioning process: which teaching and learning services and facilities should be made available, to whom, when, and how. Rather than implementing provisioning rules directly in the software applications that make up the online delivery environment, we propose a model for an educational provisioning system (EPS) that allows for highly flexible provisioning and reduces the workload drastically. This system is responsible for both expressing and processing provisioning rules that meet the demands of new (online) course models. It supports the use of so-called course access levels that enable to address and provision various learning target groups separately by means of a single course. For reasons of efficiency we suggest an architecture in which the EPS is loosely coupled to the applications in the teaching and learning environment. A first EPS implementation at the Open University of the Netherlands is presented and discussed.

# 1 Introduction

Adult learners constitute a rather heterogeneous group with a wide range of learning ambitions, prior knowledge, learning preferences and personal circumstances (Cercone, 2008; Merriam, Caffarella, & Baumgartner, 2012). The societal trend towards increased individualization (Longworth, 2003) challenges educational institutions more and more to create tailored, personalized learning offerings. However, stepping away from one-size-fits-all solutions and trying to cater for the demands of particular learner groups (segmented personalization; Martinez, 2013) or even individual learners, requires logistic processes that are very difficult to manage and will affect the provisioning process in particular. Provisioning is derived from the verb 'to provide' and refers in general to making something available (http://searchsoa.techtarget.com/definition/provisioning). Within an educational setting, provisioning can be broadly defined as the process of supplying teaching and learning services and facilities to participants (e.g. learners, tutors, and peers) involved in the learning and teaching process. Services and facilities can be physical or digital, and may relate to different educational processes. We distinguish as main educational processes:

- Primary processes, concerned with designing, developing, running and evaluating courses[6] and programmes. These processes include all services and facilities directly related to the activities of learners and teachers in the context of a course or a program, e.g. course management services, content creation services, assessment services, and communication services.
- Secondary processes, dealing with processes that are *conditional* or *supportive* to the activities in primary processes, which do not directly affect the primary processes of designing, developing, running and evaluating courses and programmes. Examples of such services are planning services, intake services or progress monitoring services.
- Tertiary processes, including all processes that are conditional or necessary, but not directly related to (supporting) teaching and learning, such as authorization and authentication services, subscription and registration services, or payment services, including voucher and credits services.

In distance education, the shift towards online education opens up new opportunities for personalized provisioning to groups or individual learners. This requires that we replace models, systems and buildings for 'stock' management with (new) solutions for provisioning and access management (Vogten & Koper, 2014). Rather than selling and

[6] 'Course' may have different meanings. In our case, a course is a unit of education with an average load of 120 hours of study, and is completed with a preliminary exam. A course can be part of a program (e.g. a BSc or MSc), but can also be completed separately.

sending learning materials, *online provisioning* means granting access to online teaching and learning services, and involves all three processes identified above. For regular educational institutions that are moving towards blended learning and open educational resources, a similar challenge exists: how to manage the logistic complexity related to flexible (online) provisioning.

From an institutional point of view, it is not hard to imagine that an increasing level of flexibility will result in a very complex access control management of the learning and teaching infrastructure. Provisioning and access management are not restricted to granting access, but also deal with revocation of access, as course registrations may have a limited period. It is not always that clear which services should be revoked when a course expires while a user still has other active registrations. Even with a fairly limited amount of users, managing access to all online resources manually would be impossible. Furthermore, we may expect that business models will change over time and with it the rules that determine online access to learning resources, as will be illustrated in the next section where we will introduce the case of the Open University of the Netherlands. This leads us to the central question this article tries to answer: *can we design a system that suits flexible, online provisioning and management of the underlying business rules?*

The approach described in this article in brief enables faculties:

- to identify *course access levels*, i.e. to label parts of courses according to their suitability for various target groups; the particular learning design of each of these course access levels depends on teachers' and faculties' pedagogical choices (Hermans, Janssen, & Koper, in press.);
- to easily define combinations of course access levels, along with services transcending a single course, to be provisioned to various target groups (primary & secondary processes);
- to apply a sustainable way to handle the multiple combinations of services, facilities and target groups in a context of swift changes (with respect to infrastructure and/or policies).

As such, this research is not so much focused on providing teachers with a means to make their learning designs interoperable (e.g. Prieto et al., 2013), but rather on enabling faculties and institutions a way to flexibly provision for different learning target groups by means of a rule-based access management system, called Educational Provisioning System (EPS).

Online provisioning is related to general IT concepts as identity management (IdM) or identy and access management (IAM), which deal with enterprise-wide managing online identities, authentication, authorization in support of access management. Related specifications in this respect are XACML (OASIS, 2013) and SPML (OASIS, 2014).

Although these specifications are potentially useful for the technical implementation of educational provisioning, they are too extensive, very technical in their nature and have no specific focus on the educational context, in particular the situation where provisioning information should be managed by non-technical faculty staff. They rather operate at enterprise level, affecting the organisation as a whole.

Rather than implementing provisioning rules directly in an online learning system, we propose a separate educational provisioning system (EPS) that allows for managing provisioning rules independent of the learning application(s) in use. We propose various adapters that will translate the outcomes of these rules into the appropriate access control settings on the various learning systems. This approach has various advantages:

- *Reliability*: there is no need for any manual configuration of the learning system. All configuration is handled by the provisioning system. This applies for both granting and revocation of access rights.
- *Efficiency*: policy changes at institutional or faculty level can be simply implemented by redefining the provisioning rules in the EPS. There is no need for any additional software changes.
- *Traceability*: the existence of explicit rules provides a reasoning mechanism making it possible to explain why users have access to certain resources.
- *Flexibility*: additional provisioning configurations, for instance for different types of users, can be added easily.

To provide a more specific understanding of typical provisioning issues at stake, we present in the next section the case of the Open University of the Netherlands (OUNL). From this case we derive the requirements for an EPS that suits online provisioning, and subsequently draw up an EPS model that allows us to express the required provisioning rules. Besides, we provide an architecture that positions the EPS in the broader context of online delivery systems. A first implementation of the proposed model will be presented in the following section. We will conclude with a discussion of our results.

## 2 A case of flexible provisioning

Below we outline how the OUNL, a distance teaching university, has addressed the issue of flexible provisioning and the logistic complexities it involves. We highlight a new course model that imposes typical demands with respect to provisioning rules.

## 2.1 Course access levels

The Open University of the Netherlands (OUNL) is a distance teaching university, offering open higher distance education. In the last decade, strategic discussions about the position of the OUNL in the landscape of higher education in the Netherlands led to redefine as OUNL's primary role to provide academic lifelong learning: to offer adult learners facilities to attain a bachelor or master degree in any phase of their lives and to keep up to date with their professions or disciplines of interest (Koper, 2014a). This ambition led to a new business model, in which the population of learners was divided into different learner target groups, each to be served with tailored offerings. In support of the business model, a new course authoring approach was developed (Hermans et al., in press). Key in this approach was to develop online courses that can be flexibly delivered to different learner groups, by dividing single courses into layers or *course access levels* (CALs). CALs are tailored to particular learning target groups by varying access to learning activities, resources, and services. To facilitate the authoring process, each course access level was represented by a different colour that addresses a different learner target learner group.

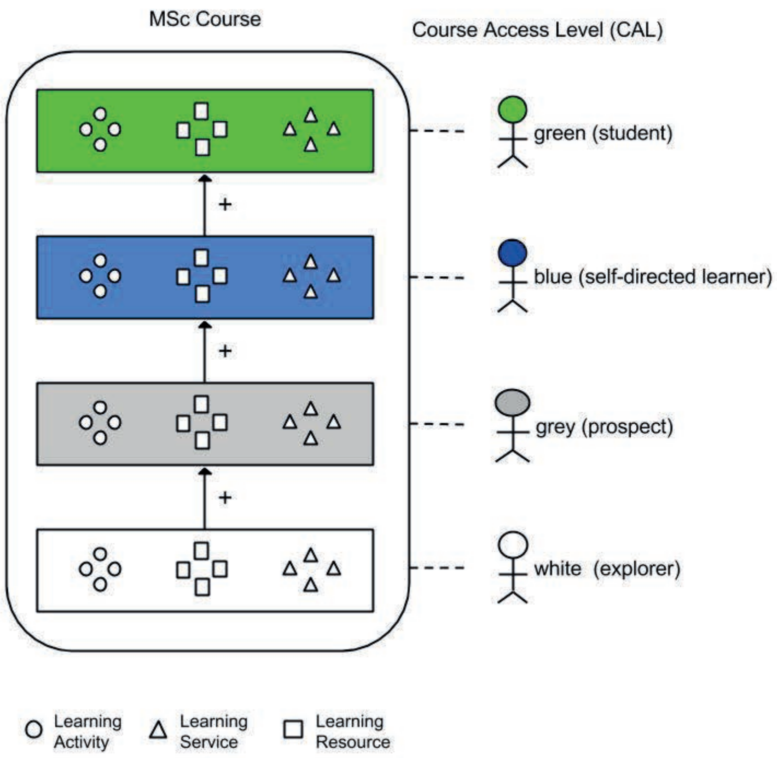


**Figure 5.1.** Course access levels MSc course

Figure 5.1 depicts the default set of CALs we used for an MSc course, along with the corresponding learner target groups. Stepping up the hierarchy of course layers, from explorers (lowest level) to regular degree students (highest level), each layer extends the lower layer with learning activities, resources and/or services, tailored to the learning use case of the particular target group. For example self-directed learners who want to keep track with new developments within their domain, receive 'blue' course access, meaning that they can access all course resources relevant to their domain, and are supplied with personal tools for managing their progress and learning results. Regular students, on the other hand, receive 'green' access, meaning that they obtain tutor guidance and that they are allowed to take course exams. For the sake of clarity, the definition of the learning activities, services, and resources to be offered at any level depends on choices at faculty and/or teacher level.

### 2.2 New educational formats

As part of implementing the new business model, new educational formats for continuous professional development (CPD; see Rubens & Hoogveld, 2012), like *learning tracks* and *online masterclasses*[7], were developed. The learning track provides a good illustration of new demands to online provisioning. A learning track aims at supporting the learning needs of the self-directed ('blue') adult learner. It is a Netflix like subscription system, offering access to all 'blue' MSc courses and all online master-classes within a domain. The business rules are reflected in the provisioning strategy. Once subscribed to the learning track, learners first of all get access to a course site that provides more information about the learning track. Furthermore, learners must be able to create their own personalized learning paths (Janssen et al., 2011). To this end, they are entitled to freely register for the 'blue' courses of their choice. Along with their subscriptions, learning track users receive access to personal tools for managing their learning processes, such as a course registration tool, a blog and a showcase tool. Together, these kinds of tools make up what can be conceived as a learner's personal learning environment (PLE; see Attwell, 2007; Hermans et al., 2014). Embedded in an institutional context, Casquero et al. (2010) characterize this as an institutionalized personal learning environment or iPLE. A final characteristic of the learning track model is that users receive an amount of credit points, which they can exchange in the learning system to gain access to paid services like online masterclasses and conferences.

[7] An online masterclass is a video-based educational format, through which experts and audience discuss trending research topics.

Both the examples of CALs and the learning track illustrate that in online education target group differentiation and new educational formats require different models for provisioning of learning and teaching services. Next, these requirements will be discussed more in detail.

## 3 Requirements

This section describes the requirements regarding the kind of provisioning rules the EPS should be able to process. To this end we return to the learning track example (see section 2) that allows us to provide the following user scenario that illustrates how a provisioning process may unfold.

*“Lily is a primary school teacher who wants to stay up-to-date in the field of learning technologies. To realize her ambition she has signed up for the OUNL’s learning system, as she intends to attend (free) online masterclasses. As a registered user she is provided with a dashboard for managing her learning process, a user profile service she can use to create a personal network, and a blog in her personal workspace (T0). She starts with registering for an online masterclass in the area of mobile learning. This registration also gives her access to a website containing state-of-the-art information and resources on the topic of mobile learning (T1).*

*As a next step, Lily subscribes for the learning track `Learning and teaching in the 21th century'. This involves a one year subscription at a monthly fee, entitling ‘blue’ access to all MSc courses and including vouchers with credits to sign up for six (paid) online masterclasses. After registration (T2) she now has access to the learning track site. Her registration also gives her membership of a portal providing trends and state-of-the-art research information in the Learning Sciences domain.*

*In addition, Lily’s personal workspace has been extended in two ways. Along with her registration, she has received credits that she can exchange in the learning system to gain access to other courses. Second, she is provided with tools for document management, knowledge sharing, and creating portfolios she will need or may find useful to support her learning track. The portfolio tool, for instance, she will need to draw a report of conducted formal and informal learning activities in the learning track accreditation process.*

*As a consequence of her learning track registration the personalized course catalogue has been extended with a large amount of ‘blue’ MSc courses Lily can freely register for. Lily decides to start with the course ‘Digital Media and Learning’ (T3). By clicking the auto-registration button she gets instant access to this course.”*

In this user scenario we encounter three kinds of rules that are relevant in the context of educational provisioning:

- *access rules*, specifying which course(s) a learner should have access to, and at which access level, such as 'green' access in the learning track example.
- *entitlement rules*, stating which course(s) a learner is entitled to register for as a result of a particular course registration. In our example the learning track registration entitles a user to (freely) register for a considerable number of 'blue' MSc courses. This type of rule makes it possible to create a fully personalized course catalogue.
- *facility rules*, granting the learner facilities like resources, (personal) tools, or credits.

Table 5.1 shows an overview of how the provisioning 'profile' of the user in our example develops over time after various course registrations. Starting with basic tool access upon platform registration the provisioning profile develops into a more and more comprehensive configuration.

**Table 5.1:** Example of provisioning 'profile' development

| Registration | Access | Entitlements* | Facilities |
|---|---|---|---|
| *T0: platform registration* | -- | -- | dashboard tool<br>profile tool<br>blog tool |
| *T1: online masterclass registration* | online masterclass ('green' access) | -- | topic community** access<br>domain portal access |
| *T2: learning track registration* | learning track ('green' access) | all 'blue' MSc courses<br>all 'topic' communities<br>all 'archived' online masterclasses | credits<br>domain portal access<br>document management tool<br>knowledge sharing tool<br>portfolio tool |
| *T3: MSc course registration* | MSc course ('blue' access) | -- | -- |

* Entitlements are granted permissions to register for a course or course access level.

** Topic communities are research communities, integrated in the learning environment, in order to make specific research areas accessible to a wider public.

With this elaborated example in mind we state the following requirements for the EPS:

R1. The EPS must support the creation of one or more CALs for an online course.

R2. The EPS must be able to express provisioning rules for each CAL. The following type of rules must be supported:

R2.1. *Course access rules*: a course access rule specifies the course(s) that must be assigned to a user in the teaching and learning infrastructure, depending on the user's course registration status.

R2.2. *Registration entitlement rules*: this kind of rule expresses that 'registration for course 1 entitles a user to register for course [2..n]'. These kinds of rules allow for conditional, personalized offerings that can be used as part of an educational format such as the Learning Track in our example.

R2.3. *Facility rules*: this kind of rule is to be used for supplying users with facilities. We use the term facilities as an umbrella term for artefacts in the learning system, which may be of a different nature. In our example, facilities relate to tools like the PLE services, resources such as the domain portal, or value tokens such as credit points.

R3. The EPS must be able to process provisioning rules as stated in requirement R2 when either a registration status of a user changes or the provisioning configuration of the CAL has been altered.

For the purpose of efficiency, and considering the design principle of 'separation of concerns' (e.g. Greer, 2008, January 8; Tarr, Ossher, Harrison, & Sutton Jr, 1999) we stated as an additional, more general requirement:

R4. The EPS must be agnostic with respect to particular applications that are in use for (1) teaching and learning, and (2) user and course administration, in order to make it robust to changes in the application landscape.

## 4 EPS model

In this section we will first introduce the EPS model for expressing provisioning rules, based on the first three requirements of the prior section. Subsequently we present an architecture that positions the EPS in relation to other systems involved in the provisioning process.

Figure 5.2 shows the EPS's conceptual model expressed in a UML class diagram (Object Management Group, 2014). A *course* is a complete, self-contained unit of education. It can manifest itself in various configurations, called *course access levels* (CALs; see also section 2), based on pedagogical choices regarding the learning needs of a particular learner target group.

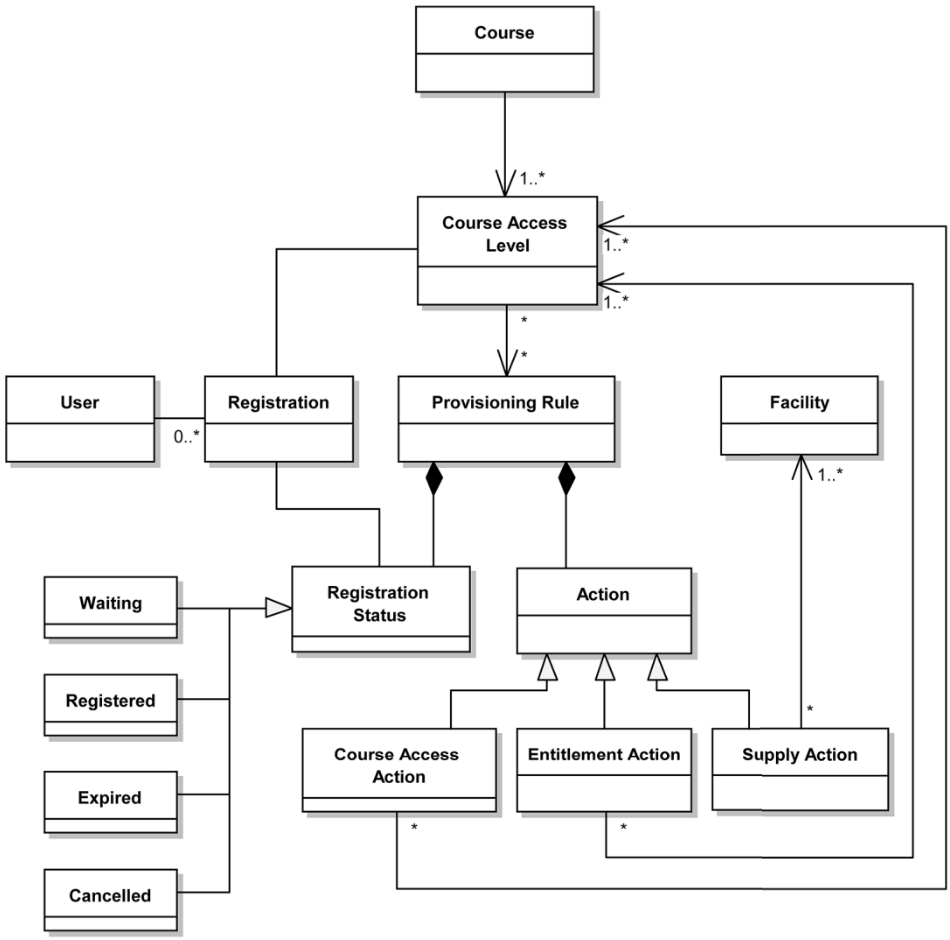


**Figure 5.2.** EPS conceptual model

For each CAL, one or more *provisioning rules* can be defined. These rules involve formalized, conditional business rules, describing the type of grants to be provided to the participants within the online teaching and learning environment, depending on their *registration status*. These business rules are based on policies, usually stated at faculty or institutional level.

A provisioning rule is associated with a user´s course registration status and expresses the provisioning action to be executed based on that particular status. Possible registration statuses are 'waiting', 'registered', 'expired' or 'cancelled'. A user may have multiple registration statuses for a CAL, as CALs can be associated with different educational formats. A user obtains a registration status when, for example, he or she is enrolled in a course. This status changes when a course registration expires.

These kinds of state changes are triggers for reapplying the provisioning rules for that user. This may result in additional changes in a user's registration statuses, which will trigger again the processing of provisioning rules.

Following requirement R2 from the previous section, we distinguish three action types: *course access action*, e*ntitlement action*, and s*upply action*. Both course access actions and entitlement actions relate to a CAL a user should be registered for, whereas supply actions address the facilities to be provisioned, such as resources, tools or learning objects.

## 4.1 Architecture

As a final requirement (R4) we stated that the EPS must be able to operate agnostic to the particular application(s) an institution has in use for teaching and learning, as well as for user and course administration. This requirement demands an application architecture in which the EPS is loosely coupled with other systems involved in the provisioning process. This implies for the EPS on the one hand that it must be able to import user registrations and course information, and on the other hand that it must be able to expose resulting user provisioning information (registrations, entitlements and facilities) that can be implemented by teaching and learning applications.

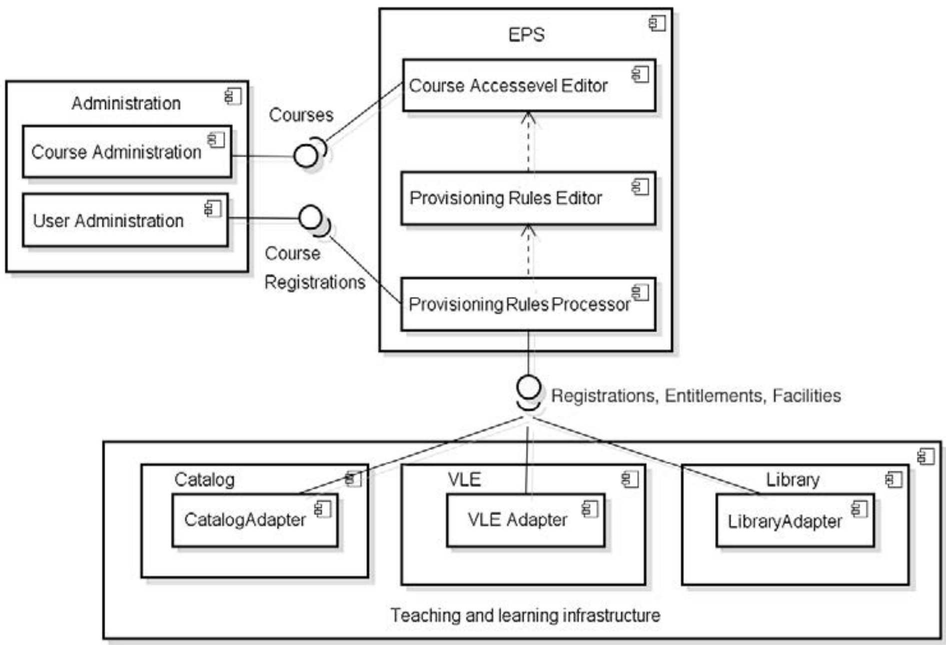


**Figure 5.3.** EPS architecture

Figure 5.3 proposes an architecture, expressed in an UML component diagram (Fowler, 2004; Object Management Group, 2014), that meets the particular requirement. It shows a high-level structure of the EPS, its main components and their dependencies.

The architecture takes the EPS as a central component, responsible for expressing as well as processing provisioning rules. The EPS expects course information (*course list*) as well as user registrations (*course registrations*) as input for both these two tasks. This information is expected to be available through interfaces (depicted as lollipops) of the administrative systems that are in use.

EPS itself is broken down into several other components, each addressing a separate concern. For example the EPS top component in the diagram is the *course accesslevel editor,* an application component that is needed to identify CALs for a particular course in order to assign provisioning rules and list a CAL for example in a catalog.

EPS *provisioning rules processor* is a service provider, to be triggered by each change in either a user's registration status or a CAL's provisioning rules. It calculates and exposes user provisioning information (*registrations, entitlements and facilities*) through a high level interface that can be called by applications in the teaching and learning environment. In order to *translate* and *implement* this high level provisioning information, application specific *adapters* are required. These adapters are expected to have sufficient access to the underlying teaching and learning applications, e.g. through available APIs. Applications lacking an API should thus be extended in order to provide the required level of access.

In order to develop adapters, it requires knowledge of how the targeted applications are expected to facilitate provisioning in terms of providing access to their services. This knowledge should be implemented a set of adapter configuration options that can be applied for the various CALs. Hence, an adapter should provide a user interface to enter these configuration options.

## 5 Implementation

A first version of the EPS was realized as part of OUNL's integrated learning system OpenU (Vogten & Koper, 2014). The Scrum software development approach (Schwaber, 2007) was used for an iterative development of the system. As the number of students was growing steadily, we were faced at an early stage with a manual and error-prone application management, as configuring access permissions in the learning system was done manually. We recognized the need to develop an automated provisioning solution instead and out of this need the EPS was developed in several iterations. Because the initial development was focussed on solving our immediate problems, it did not start as a separate layer outside the teaching and learning infrastructure as proposed in the architecture above. However, we were able to develop a solution that conceptually and technically meets the proposed provisioning system and with some effort it is possible to create a stand-alone version of this EPS that will run e.g. in a separate Tomcat application container (The Apache Software Foundation, 2014).

Below, we will first provide some details about the implementation platform and implementation context. The user story introduced in section 3 will be used to illustrate the working of the EPS.

### 5.1 Platform

The EPS was developed by a team of OUNL ICT specialists as an application within Liferay Portal EE (Liferay, 2014), an open source java-based platform. By default, the platform provides each registered user with a personal workspace that we used to implement a personal learning environment. The platform's fine-grained permissions system allows for detailed personalization and developing flexible courses as highlighted in section 2. As each PLE tool could be addressed separately, this allowed for flexible delivery. The platform's community entity was used for the delivery of online courses. A community is technically speaking a container, holding groups of pages that expose services through portlets: configurable user interface components that can be dropped and arranged on a webpage.

In order to translate and apply EPS provisioning information in the portal's formal learning environment and the course catalog (see Figure 5.4), adapters were built. Along with these adapters we developed tools to monitor proper processing of provisioning information. Manual access configuration of components was still possible, whereas the adapter guarded the proper permissions to be granted through the EPS, so no conflicts occurred when restoring permissions.

### 5.2 Implementation context

The EPS was deployed within the subject area of Learning Sciences and Technologies. In the e-learning system a total of 26 MSc courses were redesigned to meet the demands of the layered course model. New course models serving lifelong learning involved online masterclasses, MOOCs and Learning Tracks. For each of these course models a default set of CALs was defined and applied for their course instances using the EPS. Table 5.2 shows as an example an overview of CAL type's used for MSc courses.

Design documents of all course models, developed by project teams at faculty level, were analysed for the presence of provisioning statements. These statements were transformed into provisioning rules for each possible registration status, which were subsequently presented to and approved by the faculty. Subsequently, for each CAL the appropriate provisioning rules were assigned in the EPS.

**Table 5.2:** Overview of CALs for MSc courses

| CAL | Target group | Access level | Delivery |
|---|---|---|---|
| *OER* version* | interested users | white | public access |
| *Free version* | interested, registered users | grey | self-service |
| *Read only version* | learning track subscribers, MSc students | blue | self-service, only for entitled users |
| Full version | MSc students | green | automatically after payment |

* Open Educational Resource

Figure 5.4 shows the major parts of the e-learning system provisioned by the EPS was deployed: (1) a personal workspace or PLE, (2) a formal learning space for taking courses, learning tracks or online masterclasses and (3) a web shop containing a

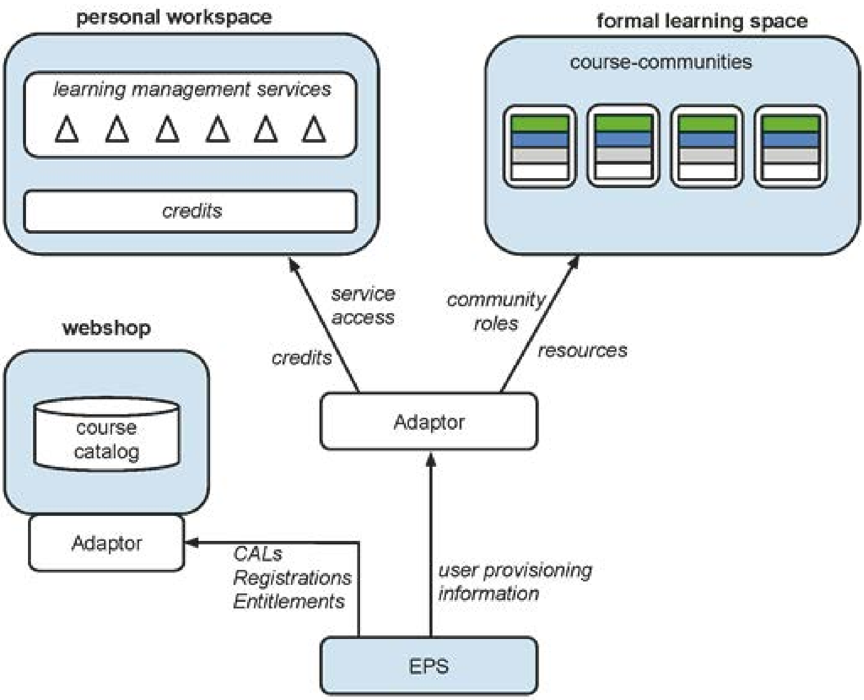


**Figure 5.4.** OUNL EPS implementation

(personalized) catalogue that lists all CALs a particular user is entitled to register for. Through a web service interface the EPS listens to changes in course registrations from the administration system (not drawn) and calculates the proper user provisioning information.

### 5.3 Example

Lily's user scenario in section 3 showed an elaborated example of how a user provisioning profile may evolve over time. Transition T1 to T2 in Table 5.1 marks her registration for the learning track. Figure 5.5 shows a screenshot of how Lily's grants at timestamp T1 affect the configuration of the learning system. Top left of the screen her personal workspace is available, providing access to learning management tools (facilities) assigned by the EPS to each person who registers at the platform (T0).

The dashboard tool at the centre of the screen displays three tiles as a result of registering for an online Masterclass. The EPS facility rules for this online Masterclass state that besides full registration for this course, the status 'registered' also gives access to the topic site 'Mobile Learning', as there is a substantive relationship between both, as well as the portal Learning Sciences.

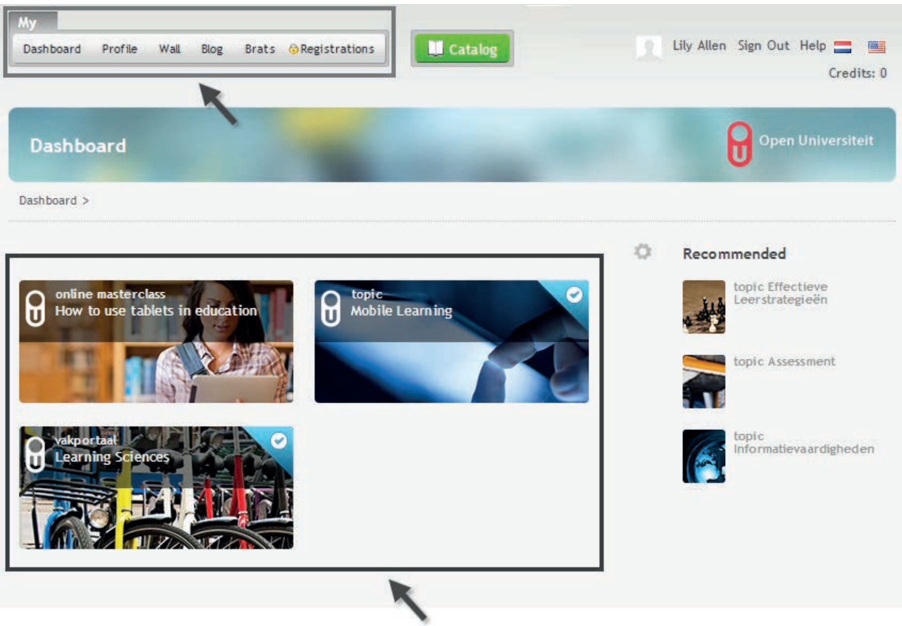


**Figure 5.5.** Learning system configuration at T1

From the moment Lily is registered for learning track (T2), the EPS extends her grants with (1) a learning track course registration, (2) an extensive collection of entitlements (which is a key feature of the learning track subscription model), (3) personal tools and credits for buying access to online masterclasses (see Table 5.1). Figure 5.6 highlights the impact of these grants on Lily's learning environment. Tools in her personal workspace are extended with a wiki and file management tool. The top right part of the screen shows an amount of 54 credits for buying online Masterclass access. The central part of screen shows the list of entitlements ('blue' courses) she can (un)register for automatically on a self-service base.

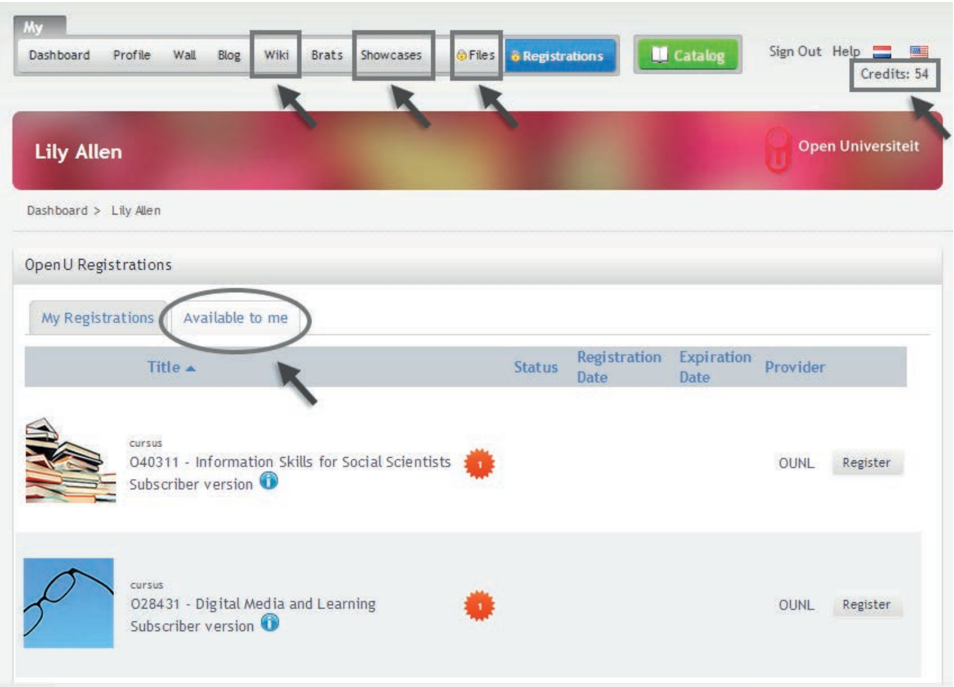


**Figure 5.6.** Learning system configuration at T2

## 6 Conclusions and discussion

In this article we have argued that for flexible and efficient provisioning for different groups of adult learners, we need a new type of system called Educational Provisioning System (EPS). An EPS allows for both managing and processing provisioning rules in order to meet the demands of new online educational formats. It supports the use of so-called course access levels (CALs), through which particular learning target groups can be addressed and provisioned separately. Provisioning rules are formalized business rules, derived from faculty and/or institutional policy, stating which services and facilities are to be provided or revoked to a learner through the software applications that are in use in the teaching and learning infrastructure. To ensure robustness with respect to changes in the application environment as well changes in the provisioning rules, we have proposed an architecture that separates the business provisioning logic from the applications that implement this logic. Besides an EPS, this architecture requires the development of adapters that translate and apply high level EPS provisioning information into the particular access permissions of the underlying applications. Adapters are expected to have access to the underlying applications for teaching and learning, e.g. through available APIs. Applications lacking this access should thus be extended in order to be used within this architecture.

A first EPS implementation was realized against the background of the development of a new e-learning infrastructure at the OUNL. Through this implementation we have been able to provision different learner target groups separately with tailored services and facilities. Moreover, this implementation allowed us to develop and run new educational formats such as the Learning Track, which requires the presence of typical entitlement rules, as supported by the EPS. For a future release of the OUNL EPS, from an architectural perspective, we are planning to migrate the EPS, currently implemented as a Liferay portal application, to a stand-alone application.

The EPS implementation proved to be an efficient solution with respect to managing and processing of provisioning rules. All provisioning rules concerned can be managed in one system, without having to worry about application specific access control, which is taken care of by the application adapter. The EPS helps to tackle the complexity of provisioning, though it can be improved in particular with respect to visualizing provisioning rules in such a way that they are better traceable by humans.

Though the examples and implementation presented in this article are restricted to web based delivery and provisioning, the proposed model and architecture are fully neutral with respect to delivery channels or devices used. The EPS provides a generic solution for flexible and efficient provisioning and as such may be expected to suit mobile delivery scenarios as well.

Finally, throughout this article we showed how the EPS provides rule-based access to courses or course access levels, using push and pull mechanisms (respectively by course access rules and). Currently these rules reflect the business model of the faculty. However, usage patterns, especially of the services provided through the pull mechanism, might be used to inform future definitions of business rules. In this respect we have only begun to explore the potential use of the EPS, moving from a system that encapsulates business policies towards a system that is capable of suggesting new policies.

# Chapter 6

# Discussion and conclusion

*"Inevitably, innovation also means stepping into the dark, going by trial and error, meeting lack of understanding, experiencing that you can insufficiently clarify to others what you mean, adapting your pace to the pace of others."*
Henk de Wolf, 1998.

This thesis presented the design of an online, integrated learning environment that supports the adult lifelong learner. The design of this system is situated in the context of a distance teaching university on the threshold of the transition to fully[8] online education, acknowledging the importance of lifelong learning, and willing to accept the consequences in terms of pedagogical concept, business processes, and – the subject of this thesis - designing and implementing a new platform with services to support learners, teachers and faculty management.

Seeking new ways to serve learners' individual needs got a new boost with the rise of the internet. OUNL research and development efforts concentrated on creating more pedagogical flexibility, leading to an advanced technology, EML, the later IMS learning design specification (chapter 2). However, its perceived complexity (see chapters 2 and 4) and the lack of proper authoring tools frustrated widespread adoption of this innovative technology in an early stage. Adapting the pace was indeed required.

The rise of promising new technologies, in particular the social web, along with increased societal and political attention for lifelong learning as well as open educational resources, led the OUNL to define a new business strategy, described through a concentric circles model, distinguishing different learner target groups (Koper, 2014a). This new strategy implied rethinking the e-learning infrastructure, while also considering the problem of high dropout rates, a fundamental weakness in classical distance teaching methods (Simpson, 2013). Building on this new business strategy and the inherent need for a non-traditional e-learning infrastructure to support it, the first question addressed in this thesis is whether it is possible to design and develop an integrated learning system that allows adult learners to plan, execute and manage their personal learning ambitions, whether in a formal or in an informal setting.

A consecutive question addressed in this thesis, is how to support various stakeholders (learning designers, teachers, management, administrators) within the organization, to provide the necessary flexibility to meet the demands of personalization in an efficient way.

[8] With fully online, we mean that all teaching and learning services are provided online, not necessarily exclusively online.

These main questions have been operationalized as follows:

1. *Can we design and implement an e-learning system that integrates the concepts of virtual learning environments (VLEs), social networks sites (SNSs), and personal learning environments (PLEs)?*
2. *How to develop a system that facilitates efficient authoring and delivery of online courses that satisfy the concentric circles model?*
3. *Can we design a system that suits flexible, online provisioning as well as management of the underlying business rules?*

Related to the above questions, this thesis presents three models as well as their first implementations, on the road to an integrated learning environment for lifelong learning: (1) an integration model, (2) an authoring and delivery model, and (3) a flexible provisioning model.

The models presented in the core chapters are mostly *conceptual models*, containing and reflecting new ideas and approaches to support lifelong learning in an online, institutional context. Moody (2005) characterizes conceptual models as "[...] design artefacts used to actively construct the world rather than simply describe it. In practice, almost all conceptual models are used directly or indirectly to develop, acquire, or modify information systems."

In discussing the practice of innovation, Denning (2004) distinguishes *inventions* and *innovations*. An invention, in his words, is "the creation of something new - an idea, an artefact, a device, a procedure". Innovation is the adoption of a new practice in a community. In our case the 'inventions' are models for integration of learning contexts, flexible authoring and flexible provisioning. Implementation of (these) models has two sides. On the one hand implementation makes a model comprehensible and tangible. It demonstrates that a model works. On the other hand implementation is needed for innovation. The primary focus in this thesis regarding implementation was to see if the models work in practice, according to the intended effects, and not - though not less important - so much on the innovation. Throughout this chapter we reflect on the models as well as their implementations. For the implementations, OUNL - the first adopter of the suggested 'inventions' - provided the context. While our implementations are specific, tailored to the needs of the OUNL, they provide valuable input to reflect on the underlying models as well as future implementations. In the next section we will review the aforementioned models in more detail.

## Review of results

### Integration model

Our idea was to create an *integrated* learning environment, bringing together the online worlds of learning in an informal, social context, learning in a formal institutional context, and self-managed learning. Participants in such an integrated learning environment may learn with and from others, either in the social or in the institutional context, and may fulfil different roles in different stages of a learning process, varying from layman to expert. As a consequence, the learning environment should provide the facilities to match learning ‘supply’ and ‘demand’ as much as possible (Hermans, Wigman, & Berlanga, 2011). We implemented this principle in several ways:

- by facilitating learners with the creation of their learner profile, that is based a template (Berlanga, Rusman, Bitter-Rijpkema, & Sloep, 2009), that makes learners identifiable in the network, promotes their visibility and awareness of others (Girgensohn & Lee, 2002), support initial trust formation (Rusman, Bruggen, Sloep, & Koper, 2010) and enables them to share personal knowledge in the network;
- by bringing different learner groups with different characteristics and experiences together in course communities;
- by providing domain portals and topic communities that connect users with similar interests;
- by applying push mechanisms, that along with registration for courses or master-classes, instantly subscribe users to related portals and topic communities; and
- by providing course recommendations and a dedicated tool for peer support.

Integration also enhances the range of learning opportunities, as learners can easily switch between the institutional context and the social context for learning. Another benefit of integration is that it makes it a lot easier to capture and store users’ learning paths for purposes of monitoring, reflection, assessment, sharing, or recommendation. In our implementation, users’ learning paths are displayed as activity streams that contain their activities performed throughout the platform. These activity streams are made available in users’ personal workspaces, and shared within their personal learning networks. For the purpose of monitoring, reflection and assessment learners can add a selection of their learning path to a showcase to be shared with others either within the learning environment or beyond.

As traditional learning platforms, having an institutional rather than a learner orientation, did not satisfy our integration model, a more generic open source, social portal platform (Liferay) was chosen. This platform offers an out-of-the-box collection of services that were particularly suited for configuration of the social and personal context. Using a Scrum-based software development approach (Schwaber, 2007), we incrementally extended platform services with specific learning services for the institutional context, like course services and self-assessment services, as well as the personal context, e.g. a service for creating and sharing showcases. Some existing platform services were extended to suit specific demands of a learning network. For instance, the user profile service has been adjusted in order to create a dedicated learner profile template and to improve learner control for sharing profile information.

The new infrastructure, called OpenU, was made available within the subject area of Learning Sciences and Technologies at an early stage. As a guiding principle for the configuration of the learning environment with respect to personalization, we applied the model of segmented personalization (Martinez, 2013). This approach means dividing a population into smaller groups, based on common characteristics. In accordance with the learner target groups identified in the OUNL business model, we applied possible use cases for learning, ranging from exploring learning opportunities to continuing professional development (Koper, 2009a), to divide the learner population. In our implementation, this resulted in a broad landscape of (new) institutional offerings tailored to the needs of the different target groups. In order to make this approach of increased variety and flexibility sustainable, it was necessary to reconsider existing models of authoring and delivery.

**Authoring model**

The need for more flexibility requires an efficient course development process. To this end we designed a new course authoring model. The core idea within this approach was to create online courses that can easily be personalized to different learner target groups with respect to learning activities, learning resources, and/or learning services. We used IMS Learning Design as a conceptual framework because of its pedagogical expressiveness, the support of different learner roles, needed for segmented personalization, and because of substantial experiences with this specification (see also chapter 2). Regarding personalization we limited to IMS LD level A, preventing potentially complex scenarios that require the more complex IMS level B.

We developed an authoring approach that is powerful enough to create highly flexible online courses, while overcoming three important drawbacks of IMS LD tools: they generally (1) require too much IMS LD knowledge from authors, (2) do not allow for runtime adaptation, and (3) lack a quick preview of the learning design in action.

The core of this approach was to create course templates that (1) reduce author complexity by restraining substantial parts of the learning design, (2) integrate both an

LD editor and a player, and allow authors to switch between design time and runtime, and (3) provide a colour scheme for personalization purposes.

So for authors, creating a flexible course fitting OUNL's concentric circles model in fact means not much more than developing a 'regular' course, except that at some point in time, activities have to be explicitly assigned to the target groups. The subsequent process of flexible delivery, or better provisioning, is handled by a different system, the Educational Provisioning System (EPS), based on a new model for provisioning.

**Provisioning model**

For educational institutions, that want to serve different learner groups with a variety of (online) offerings in different configurations, an efficient approach is needed regarding the process of *provisioning*, i.e. the process concerned with which teaching and learning services and facilities should be made available, to whom, when, and how. Moreover, for the sake of sustainability, it requires a robust solution, as institutional policies as well as services and facilities may change over time.

We developed a conceptual model for online, rule-based provisioning (EPS), built around the concept of *course access levels* (CALs). CALs are course parts, tailored to particular learning target groups by varying access to learning activities, resources, and services.

The EPS model was implemented as part of the OUNL's integrated e-learning infra-structure and fulfils three major functions:

1. to identify one or more CALs for a particular course;
2. to assign provisioning rules to each CAL;
3. to process provisioning rules and to expose user provisioning information to applications within the teaching and learning infrastructure.

The system is best positioned as a kind of service layer between administrative systems and application(s) that are in use within the teaching and learning infrastructure. As such it expects administrative systems to expose course information, in order to create CALs, and requires student subscription information to process provisioning rules. EPS output is available through a high level interface. Application specific *adapters* are needed to translate and implement this user provisioning information into the proper access permissions of a particular learning application.

For online provisioning, as in the case of our pilot, at least three types of provisioning rules are of relevance. *Access rules* allow for specifying the CAL(s) to be supplied to a learner, as a result of registration for a particular offering. *Entitlement rules* state which CAL(s) a learner is entitled to register for, as a result of registration for a particular offering. *Facility rules* describe the facilities to be granted to a learner, such as in our case social tools, learning management tools, or credits. This collection of rules constitutes a powerful way to express business rules for a range of educational offerings. For example, access rules were used to push membership of domain portals and topic communities. Entitlement rules were applied within educational formats such as the Learning Track, thus providing learners a means to self-register for the range of CALs that are part of a particular Learning Track.

More generally speaking, the EPS on the one hand makes it possible to break down and flexibly deliver single courses, while on the other hand, it provides a mechanism to create new kinds of offerings, such as the Learning Track, by combining CALs using access and entitlement rules. Efficiency was reached by managing all provisioning rules in one system, and not having to grant and revoke user permissions manually in the e-learning applications. Moreover, robustness was ensured by implementing the EPS as a separate service, resistant against changes in existing provisioning rules.

Though examples and implementation focused on web-based provisioning, the proposed model and architecture are fully neutral with respect to delivery channels and devices. The EPS provides a generic solution for flexible and efficient provisioning and as such suits mobile delivery scenarios as well. With minor extensions, we believe it also has the potential to efficiently serve provisioning of tangible learning materials as well.

## Conclusion

Through our OpenU implementation we have demonstrated that it is possible to develop an e-learning system that allows adult learners to plan, execute and manage their personal learning ambitions, whether in a formal or in an informal setting (design question 1 of this thesis). OpenU integrates institutional, social, and personal contexts for learning, and allows learners to seamlessly switch between these contexts. In addition, the implemented authoring and provisioning models illustrate how to support business processes so that personalization can be achieved in an efficient way (design question 2). In our approach, authoring courses for different learner target groups is not substantially different from the regular course authoring process. The complex process of online provisioning has been reduced to maintaining provisioning rules. The remainder, being the processing of rules and applying the proper access permissions in the e-learning system, is taken care of by the EPS and an application specific adapter.

As argued in this thesis, implementing an integrated model for learning requires quite a different e-learning infrastructure as compared to current VLEs. The choice of a generic portal platform for integration of the different learning contexts gave us a jump-start for configuring the social and personal context. An analysis by Vogten & Koper (2014) showed that roughly 80% of the software code in our final implementation can be considered as standard platform code. From this, it can be concluded that generic, extensible, social platforms are well suited to serve as a new generation (integrated) learning environments. However, it is obvious that configuring a generic environment for a specific purpose will require more effort than deploying a traditional, dedicated learning management system. As in our implementation, the portal platform and its platform services provide respectively the foundation and the building blocks for developing the learning environment. Building the learning environment means configuring the platform, its components, and (learning) services consistent with the pedagogical vision. Although this platform configuration requires more effort, this is balanced by the benefits of using a generic environment. Nevertheless, when choosing a platform the aspect of configuration management should be carefully considered.

The OpenU system was stepwise developed in close cooperation with the staff of the department of Learning Sciences and Technologies. The experiences gained in practice by teachers and learners, both end users of the system, and administrators, responsible for the configuration of the system, were used to improve functionality of the technical services as well as to improve the configuration of the learning environment. The use of Scrum proved to be a valuable approach in this respect, as working in short iterations allowed us to correct for reported software bugs and configuration errors at an early stage.

**Integration**

As learning is not limited to a specific institution or period of time, Conde, García, Rodríguez-Conde, Alier, & García-Holgado (2014) state that institutional learning environments should be open in order to enable the export of functionalities and import of information and interaction from outside the institution. Regarding the scope of the integrated learning environment presented, one might get the impression from the implementation, which was guided by the OUNL's business strategy, that our approach has a rather internal, institutional focus. However, this is not the case, not for the model and (on closer inspection) not for the implementation either. As explained, the model in abstracto distinguishes between an institutional, social, and personal context for learning. There are neither restrictions regarding the number of educational providers that populate the institutional environment, nor does it limit the social and personal context to one, single platform.

Our implementation in terms of platform architecture, platform services and platform configuration shows no fundamental obstacles in this respect. Both export and import of services and data are supported in multiple ways. For example inside out, the platform has an API that can be queried by external services, all applications (portlets) can be exported or 'shared' as applications or widgets in other, web-based environments, and various applications provide RSS[9] feeds, allowing users to instantly digest learning network updates in their preferred environments. Outside in, the platform has an OpenSocial container (OpenSocial Foundation, 2014) for hosting OpenSocial compatible (social networking) applications as widgets, and users can synchronize (parts of) their OpenU user profiles with their LinkedIn profiles. Furthermore, the learning track format (see chapter 5) uses a showcase application for assessment of learning progress, that allows for integration of external, web-based resources as 'evidence' for learning. This application is a spin-off from the European Trailer project (Brouns et al., 2014).

Recently, and in line with the approach of building bridges between institutional and informal learning environments, the Advanced Distributed Learning (ADL) initiative launched the xAPI or the Experience API (Advanced Distributed Learning, 2014), also known as the Tin Can API, a specification that "describes an interface and the storage & retrieval rules that developers can implement to create a learning experience tracking service". Tools that implement this specification can capture informal learning activities or 'experiences' from a variety of technologies and store them in a standardized format in a repository or Learning Record Store (LRS), which may exist as part of a learning environment. Other (learning) systems, in their turn, can be granted access to the LRS. To conclude, the xAPI specification has the potential to play an important role in the social, informal context of lifelong learning, and hence implementation in an integrated learning environment should be considered as a serious option.

Export of functionalities, as stressed by Conde et al. (2014), may also play an important role regarding learner control and ownership of learning, which are core values in lifelong learning. Though ownership of learning doesn't necessarily imply ownership of learning tools, a fully provider-driven PLE (Mcloughlin & Lee, 2010), as in our implementation, may negatively affect the *sense of ownership* and therefore user acceptance. For this reason, learners were granted full control in configuring their personal workspaces at an early stage of our OpenU implementation. This meant that, similar to mash up environments, they could manage and structure personal pages with configurable platform applications for learning management. So the learner might, for example, choose to combine a file storage and a blog application on one and the same page. Furthermore, they could embed these applications into their preferred personal

[9] RSS is a web content syndication format (http://www.rssboard.org/rss-specification). Through RSS feeds users can subscribe to frequently published information.

environments, such as (the former) iGoogle or Netvibes ("Netvibes" 2014). However, as a significant number of users lacked the necessary digital skills and in the absence of platform possibilities to reset users' personal workspaces in a simple way, we restricted learner control regarding the configuration of their personal workspace. Further research is needed to determine the right balance between available digital skills and functionality to be offered. Ideally, the learning environment should adapt its functionality according to the learners' skills in this respect.

**Personalization**

In chapter 1 of this thesis, personalization of learning was stressed as an important factor in institutional strategies towards lifelong learning. We discussed that in (online) learning systems various approaches to personalization may exist, differing from one another with regard to what is personalized, how is personalized, and who is in control of personalization (the learner or the system).

Driven by OUNL's business strategy, we applied the model of segmented or target group personalization in the institutional context of the OpenU implementation. By using course access levels (CALs), supported by the authoring system as well the provisioning system, we were able to adapt single courses to different types of learners with respect to learning activities, learning resources, learning services, personal tools, registration entitlements, and facilities. This segmentation was not present in the social context, as a heterogeneous learner population is an important factor in networks for lifelong learning. New, unexpected combinations of knowledge may emerge by bringing people with diverse backgrounds together (Van der Klink, Janssen, Boon, & Rutjens, 2011).

Since we restricted to IMS LD level A in the authoring approach, to avoid author complexity, there was no adaptivity *within* the CALS. This would make learning even more personal, e.g. by adapting the learning design to personal characteristics such as prior knowledge or learning style (see also chapter 2). This kind of adaptivity requires the use of IMS LD level B concepts, such as properties, to store learner information, and conditions, that make it possible to reason about the learning design-based on learner property values. The challenge for further research and development is how to reach this more detailed level of personalization, while keeping authoring complexity to a minimum. Griffiths, Beauvoir, Liber, & Barrett-Baxendale (2009), discussing the approach of IMS level B applied in the ReCourse editor, propose to provide the non-technical author with templates for the most frequent uses of level B, whereas technically expert authors can create more complex personalization strategies.

Our approach imposed no restrictions to adaptability (learner control) of courses. However, there were no explicit requirements for teachers and course developers put forward in this respect. As a consequence, this had no focus in the design of courses.

## The way ahead

Our implementation led to validation of the models proposed, innovation of courses within the MSc Learning Sciences and a spin-off to other faculties (Informatics, Psychology, and Management Sciences) within the OUNL. After a substantial pilot, the OUNL board decided in 2014 to extend the use of this new type of learning environment to the entire institution. However, not to the full width, but for the time being with considerable restrictions when it comes to services for lifelong learning. A first reason for this is the changed political climate in the Netherlands, in which lifelong learning is increasingly perceived as an individual responsibility, and scholarships and funding are restricted to initial education. This issue has been explicitly been addressed in a recent report by a Dutch governmental commission on flexible higher education for adults by proposing a different funding system to encourage participation of adults in higher education (Dutch Ministry of Education, Culture and Science, 2014). Secondly, due to amended legislation the OUNL will be evaluated in the near future by its number of graduated degree students. For this reason, OUNL priorities have shifted to improve efficiency of degree programmes, based on a new model for distance learning (Koper, 2014b). The third and final reason is acceptance within the organization. The OUNL has been frequently subject to organizational change. Deploying a new learning environment, that is intended to replace existing learning platforms, again implies change. This calls for an incremental approach, requiring staff involvement and acceptance.

A final remark relates to the potential of particularly the integration model described in this thesis. We believe that it is well suited for establishing a broad, regional or even national system for lifelong learning, where various institutional providers may offer their courses and programmes for part-time study[10]. As highlighted earlier in this discussion, both the model and implementation show no constraints in this respect. However, to realize such an ambition requires a political climate in which lifelong learning is perceived as a shared, public and private responsibility, for which the government is prepared to provide the proper funding.

[10] Besides the OUNL, the OpenU platform has also hosted courses, portals or online masterclasses for other providers such as Nuffic (http://www.nuffic.nl/), Zorgacademie Parkstad (http://zorgacademie.ou.nl/), and Kennisnet (http://www.kennisnet.nl/).

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# Summary

People learn in a variety of contexts, intentionally or unintentionally. These contexts may be designed to support learning, as in the case of formal learning, while others (the majority) are not. In addition to existing contexts, the *online* learning context has developed immensely in the last two decades, opening new doors to learning and providing challenging new ways for ubiquitous interaction.

Nowadays, the *formal* context for online learning is dominated by applications we know of as Virtual Learning Environments (VLEs) or Learning Management Systems (LMSs). VLEs have become an almost indispensable part of the teaching and learning infrastructure in schools and universities. They have been typically designed for formal instructional purposes, providing common features for content creation, communication, (formal) assessment and administration.

The *informal* context for online learning is probably the whole web, but is more particularly shaped by social networking sites (SNSs), providing facilities for profiling, networking, storing and sharing of artefacts, recommending and monitoring network activity.

In order to keep up-to-date within one's profession, to stay attractive for future employers, or more in general to keep up with new technological developments, people (adults) have to keep learning continuously (lifelong learning). In lifelong learning, typically the learner is in control of his/her learning, not the institution. The learner is self-directed, meaning that he or she takes the initiative, with or without the assistance of others, in diagnosing learning needs, formulates learning goals, identifies human and material resources for learning, chooses and implements appropriate learning strategies, and evaluates learning outcomes.

When educational institutions such as the OUNL want to integrate lifelong learning in their business strategies, it means transitioning from a teacher-centred model to a learner-centred model. This implies the development of ideas and models on how to support informal learning and a high degree of flexibility in providing services, different strategies for developing and delivering courses and programmes. Moreover, it requires a flexible e-learning infrastructure, allowing for personalized learning. Against this background, the first design question addressed in this thesis is:

> *Is it possible to design and develop an integrated learning system that allows adult learners to plan, execute and manage their personal learning ambitions, whether in a formal or in an informal setting?*

A consecutive question this thesis deals with, is:

> *How to support various stakeholders (learning designers, teachers, management, and administrators) within the organization, to provide the necessary flexibility to meet the demands of personalization in an efficient way?*

In answer to these questions, this thesis presents three models as well as their first implementations, heading toward an integrated learning environment for lifelong learning: (1) an integration model, (2) a course authoring and delivery model, and (3) a flexible provisioning model.

The context, in which this research was conducted, is that of the Open University of the Netherlands (OUNL), a distance teaching university with a tradition in research, development and practice of flexible solutions to meet the demands of a hetero-geneous, adult learner population. Initially, and before the digital turn, by a high degree of openness with respect to place, time and pace, and freedom for learners to determine their own learning paths. With the rise of the digital age, new possibilities for computer mediated personalization, adapting the learning process to personal preferences and characteristics of learners, became within reach.

Chapter 2 describes in this respect how - at an early stage - an important step was taken with the development of educational modelling language (EML), the predecessor of IMS Learning Design (IMS LD). The chapter discusses the underlying pedagogical meta-model, which allows for a maximum of pedagogical flexibility. It outlines the design steps needed to implement a pedagogical design in EML, and shows how EML - through its method section - can be used for personalization purposes. The chapter concludes with a retrospective, in which we indicate that in the early years the first generation IMS LD tools appeared to be too ambitious for large-scale use at the OUNL.

New technologies, in particular the social web, along with increased societal and political attention for lifelong learning as well as open educational resources, led the OUNL to define a new business strategy, with the focus on enhancing student retention and addressing different learner target groups, as described in a concentric circles model. This new strategy implied rethinking the traditional e-learning infrastructure.

Against this background we designed, developed, and implemented a new system for lifelong learning (chapter 3). The idea was to create an online learning environment that brings together the online contexts for formal learning, informal learning and self-managed learning by merging respective concepts of VLEs, SNSs and personal learning environments (PLEs). To this end, we constructed a high level conceptual model for integrated learning that elaborates on Koper's pedagogical meta-model for learning (see chapter 2).

As traditional learning platforms have an institutional rather than a learner-centred orientation, we implemented the model in a generic, social portal platform, having a service-based architecture and allowing for extensive personalization. The platform offered an out-of-the-box collection of services that particularly suited the configu-ration of the social and personal context. We extended available platform services with specific learning services for the institutional context, like course and self-assessment services, as well as the personal context, e.g. a service for creating and sharing showcases.

The various contexts for learning were implemented as follows:

1. The personal context was implemented through a personal workspace, comprising a tailored collection of personal services e.g. for planning (My Dashboard) profiling and networking (My Profile), social interaction (My Wall), reflection (My Blog), knowledge sharing (My Wiki) and file storage and sharing (My Files).
2. The institutional context was shaped by a collection of courses in various formats, ranging from MSc courses to MOOCS, containing typical services for formal learning.
3. The social context was integrated in the previous two contexts, for example by incorporating profiling and networking facilities in personal workspaces, or by implementing courses as communities that offer services for social interaction and activity streams to monitor community activity.

We deployed the integrated learning environment, called OpenU, within the pilot domain of Learning Sciences and Technologies. MSc courses were redesigned for flexible use in OpenU. Besides existing course types, such as MSc courses, and open educational resources (OER), new, tailored formats were developed, such as learning tracks, online masterclasses, domain portals, and topical research communities. Our implementation of the integration model demonstrates that it is possible to develop an e-learning system that integrates the concepts of VLEs, SNSs, and PLEs.

The transition to a learner-centred model obviously has implications for the design and delivery of courses and requires educational institutions to equip teachers and staff with the necessary tools to create efficient and sustainable solutions. The second design question of this thesis, concerned with efficiently supporting an organization in this respect, was addressed in chapters 4 and 5.

In chapter 4, we went more into detail in the concentric circles model, representing the OUNL's new business strategy. The model divides the adult learner population into separate learner target groups, each with a separate use case for learning and to be served with custom offerings. To support teachers facing the task of developing these custom offerings, we stated as a more specific design question: *how to develop a system that facilitates efficient authoring and delivery of online courses that satisfy the concentric circles model?*

We designed a new authoring approach around the idea of creating flexible courses that can easily be personalized to different learner target groups (segmented personalization) with respect to learning activities, learning resources, and/or learning services. We used IMS LD as a conceptual framework because of its pedagogical expressiveness, the support of different learner roles needed for segmented personalization, and experiences earlier gained (see chapter 2). At the same time, we tried to overcome some important drawbacks of IMS LD tools in that they generally (1) lack higher representations, requiring too much IMS LD knowledge from authors, (2) don't allow for runtime adaptation of the learning design, and (3) lack a quick preview of the learning design in action.

The core of the authoring approach was to create course templates that (1) reduce authoring complexity by restraining substantial parts of the learning design, (2) integrate both an LD editor and a player, and allowing authors to switch between design-time and runtime, and (3) provide a simple, task oriented way to personalize.

To be able to implement this approach, we developed both a purposed IMS LD editor (level A) and an IMS LD player as applications within the OpenU e-learning system. Course templates, integrating both applications, were developed standardizing parts of the learning design, such as roles and services.

The resulting authoring and delivery system was deployed within the domain of Learning Sciences and Technologies. From May 2011 until February 2014 a total of 59 online courses were developed and delivered while using this approach. Authoring efficiency was reached, as creating a flexible course that fits OUNL's concentric circles model, in fact meant not much more than developing a 'regular' course, except that at some point in time activities have to be explicitly assigned to the learner target groups. Our implementation also showed that it is possible to break down the walls between IMS LD authoring and delivery, while collected usage data validated the requirement of runtime adaptation as 59% of all course activities had been modified or even created in runtime.

In chapter 5 we shifted attention to the process of *provisioning*, i.e. the process concerned with which teaching and learning services and facilities should be made available, to whom, when, and how. For an educational institution that wants to serve different learner groups with a variety of online offerings in different configurations, an efficient provisioning approach is required as managing access to all online services and resources manually is very complex and error-prone. Moreover, a robust approach is required for reasons of sustainability, as institutional policies as well as services and facilities may change over time.

Through an analysis of the different online educational formats, we identified three kinds of rules needed for online provisioning: access rules, entitlement rules and facility rules. We subsequently drew up requirements for a rule-based, educational provisioning system (EPS) and developed a conceptual model, built around the concept of *course access levels* (CALs). CALs are specific course configurations that serve particular learning target groups by varying access to learning activities, resources, and services. The EPS model was implemented as a back-end application within OUNL's integrated e-learning infrastructure. It fulfils three major functions:

1. to identify one or more CALs for a particular course;
2. to assign provisioning rules to a CAL; and
3. to process provisioning rules and to expose user provisioning information to applications within the teaching and learning infrastructure.

To make it robust, we positioned the EPS as a service layer between administrative systems and the teaching and learning infrastructure that provides the actual teaching and learning services. An application specific adapter was developed to translate and implement EPS provisioning information into the proper access permissions of the learning system.

The resulting EPS constitutes an *efficient* provisioning solution. The whole process of provisioning can be managed through this system, without having to worry about application specific access control, which is taken care of by the application adapter. Managing provisioning rules in this way is a rather specialized task, and requires a carefully designed and well thought out user-interface, in particular regarding traceability of rules.

In chapter 6 we reviewed both models and implementations for integration, authoring, and provisioning, discuss our results and provide future research and implementation perspectives. We concluded that both design questions have been answered affirmatively, as (1) the OpenU implementation integrates institutional, social, and personal contexts for learning, and allows learners to seamlessly switch between these contexts, and (2) we have developed efficient solutions for both the authoring process and the provisioning process considering the flexibility needed for personalization. We noted that the generic, extensible, social platform chosen is well-suited for the implementation of a new generation (integrated) learning environments.

Both the integration model and its implementation contain no fundamental barriers for extending the institutional context with multiple providers, thereby increasing choice for learners. We showed that our implementation is open with respect to import and export of data and functionality. For future implementation, we propose in this respect to examine possibilities of the Experience API (xAPI), recently launched by the Advanced Distributed Learning (ADL) initiative.

Segmented personalization, a central theme within this thesis, has been realized using differentiated course access levels (CALs), supported by the authoring system as well the provisioning system. Making use of CALS, we have been able to adapt courses to different types of learners with respect to learning activities, learning resources, learning services, personal tools, registration entitlements, and facilities. For future implementation, we propose the use of IMS LD level B concepts to reach a more detailed level of personalization *within* CALS, hereby distinguishing between technical and non-technical authors in the authoring environment.

# Samenvatting

Leren vindt plaats in uiteenlopende contexten, doelbewust of niet doelbewust. Contexten kunnen speciaal ontworpen zijn om leerprocessen te bevorderen, zoals in het geval van formeel, institutioneel leren, maar veelal is dit niet het geval. Naast meer traditionele contexten heeft vooral de *online* context voor leren zich in de afgelopen twee decennia exponentieel ontwikkeld en nieuwe deuren geopend voor leren en interactie.

De huidige, *formele* context voor online leren wordt gedomineerd door het type applicaties, dat wij kennen als ELO's, oftewel elektronische leeromgevingen. Dit type applicatie is een niet meer weg te denken onderdeel van de infrastructuur van scholen en universiteiten. ELO's zijn ontworpen ter ondersteuning van reguliere instructie-processen en bieden in het algemeen voorzieningen voor het ontwikkelen en uitleveren van leermaterialen, voor communicatie, toetsing en beheer van leerprocessen.

De *informele* context voor online leren vormt in feite het hele Internet. Meer in het bijzonder wordt het gefaciliteerd door sociale netwerksites, die mogelijkheden bieden om profielen aan te maken, netwerken op te bouwen, artefacten te beheren, te delen, aanbevelingen te doen en te volgen wat er in het netwerk gebeurt.

Volwassenen moeten zich continue blijven ontwikkelen; om bij te blijven in het vak-gebied, aantrekkelijk te zijn voor toekomstige werkgevers of überhaupt om tred te houden met nieuwe technologische ontwikkelingen. Kenmerkend voor levenlang leren is dat lerenden zelf de regie hebben over hun leerprocessen, niet de onderwijs-instelling. Dit betekent dat zij zelf, met of zonder hulp van anderen, het initiatief nemen in het bepalen van hun leerbehoefte, leerdoelen definiëren, personen en bronnen selecteren, geschikte leerstrategieën kiezen en toepassen, en leerresultaten evalueren.

Voor onderwijsinstellingen die levenlang leren willen opnemen in hun bedrijfs-strategie, betekent dit dat zij hun onderwijsmodel dienen te transformeren van een aanbod gestuurd, docent gecentreerd model naar een vraag gestuurd, student gecentreerd model. Dit vraagt om zowel het ontwikkelen van ideeën en modellen ter ondersteuning van informeel leren als een hoge mate van flexibiliteit in het uitleveren van diensten, cursussen en onderwijsprogramma's. Het vereist bovendien een flexibele e-learning infrastructuur, die personalisatie van leren mogelijk maakt. Tegen deze achtergrond is de eerste ontwerpvraag in dit proefschrift als volgt geformuleerd:

> *Kunnen wij een geïntegreerd leersysteem ontwerpen en ontwikkelen dat het voor volwassen lerenden mogelijk maakt persoonlijke leerambities te plannen, uit te voeren en te beheren, hetzij in een formele of informele omgeving?*

Een tweede vraag die hier direct mee verband houdt, en in dit proefschrift aan de orde wordt gesteld, luidt:

> *Hoe kunnen we de verschillende belanghebbenden (docenten, management, beheerders) binnen een onderwijsinstelling ondersteunen om op een efficiënte manier de voor personalisatie vereiste flexibiliteit te kunnen bieden?*

Ter beantwoording van beide vragen beschrijft dit proefschrift een drietal modellen, alsmede hun eerste implementatie: (1) een model voor een geïntegreerd, online leersysteem, (2) een model voor flexibele cursusontwikkeling en (3) een model voor flexibele uitlevering van cursussen.

Deze modellen en hun implementaties zijn ontwikkeld binnen de context van de Open Universiteit Nederland, een instelling voor open hoger afstandsonderwijs met een traditie in onderzoek, ontwikkeling en toepassing van flexibele oplossingen voor de heterogene populatie van volwassen lerenden. Het onderwijs van deze instelling kenmerkt zich traditioneel door een hoge mate van vrijheid ten aanzien van plaats, tijd, tempo en leerpad. Met de opkomst van het digitale tijdperk kwamen nieuwe mogelijkheden binnen handbereik om - via computer gemedieerde personalisatie – leerprocessen verder af te stemmen op persoonlijke voorkeuren en kenmerken van volwassen lerenden. Hoofdstuk 2 beschrijft hoe in dit opzicht een eerste stap werd gezet met de ontwikkeling van een ‘educational modelling language’ (EML), de voorloper van de in 2003 vastgestelde IMS Learning Design specificatie (IMS LD). Het hoofdstuk behandelt het aan EML onderliggend didactisch metamodel, dat ontwikkeld werd om maximale didactische variatie mogelijk te maken. Het beschrijft de ontwerpstappen die nodig zijn om een didactisch ontwerp in EML uit te werken, en toont hoe EML gebruikt kan worden voor personalisatie doeleinden. Het hoofdstuk besluit met een retrospectief, waarin we vaststellen dat gebruik van de eerste generatie IMS LD tools in een vroeg stadium te ambitieus bleek voor grootschalig gebruik binnen de OUNL.

De opkomst van nieuwe online technologieën, in het bijzonder het sociale web, samen met toenemende maatschappelijke en politieke aandacht voor levenlang leren en open educational resources (OER) vormden voor de OUNL in 2008 aanleiding een nieuwe bedrijfsstrategie te formuleren. Deze strategie richtte zich op het bedienen van verschillende doelgroepen volwassen lerenden met een toegespitst aanbod. Deze strategie werd vertaald in een zogenoemd *concentrische cirkels model* en vormde aanleiding de bestaande e-learning infrastructuur te heroverwegen.

Tegen deze achtergrond is een nieuw systeem voor levenlang leren ontworpen, ontwikkeld en beproefd (hoofdstuk 3). Uitgangspunt was een online leeromgeving te ontwikkelen die de functionaliteit van verschillende online contexten voor formeel leren en informeel leren verenigt. Als vertegenwoordigers van deze contexten zijn respectievelijk ELO's, sociale netwerksites (SNS's), en persoonlijke leeromgevingen (PLE's) genomen. Principes uit deze contexten zijn geïntegreerd in een conceptueel model voor een leersysteem leren, dat voortbouwt op het didactisch metamodel uit hoofdstuk 2.

Gezien de beperkingen van traditionele ELO's, die de regie over leerprocessen vooral bij onderwijsinstellingen en hun docenten leggen en niet zozeer bij de lerenden, werd besloten het ontwikkelde model te implementeren in een open source sociaal portaal platform met uitgebreide mogelijkheden voor personalisatie. Het gekozen platform (Liferay) biedt standaard een uitgebreide verzameling diensten (applicaties), die met name geschikt zijn voor de inrichting van de sociale en persoonlijke leercontext. Deze verzameling diensten is vervolgens door een team van ICT ontwikkelaars van de OUNL uitgebreid met typische diensten voor de formele leercontext, zoals applicaties voor ontwikkeling van cursusstructuren en zelftoetsen, alsmede diverse diensten voor de persoonlijke context, bijvoorbeeld voor het maken en delen van portfolio's (showcases).

Meer concreet zijn de verschillende leercontexten als volgt geïmplementeerd:

1. De persoonlijke leercontext is uitgewerkt als een persoonlijke omgeving binnen het platform. Deze persoonlijke omgeving omvat diensten voor met name planning (Mijn Dashboard), profilering en social networking (Mijn Profiel), sociale interactie (Mijn Muur), reflectie (Mijn Blog), kennisdeling (Mijn Wiki) en opslag en delen van bestanden (Mijn Bestanden).
2. De formele leercontext is vormgegeven door een gedifferentieerd, institutioneel aanbod van onderwijsdiensten, variërend van cursussen tot MOOCs.
3. De informele, sociale context is geïntegreerd in beide bovenstaande contexten, bijvoorbeeld door profiel en sociale netwerkdiensten aan te bieden in de persoonlijke omgeving, en door cursussen te implementeren als communities met diverse diensten voor sociale interactie, en activiteitenstromen voor het volgen van activiteiten van deelnemers in de community.

De ontwikkelde leeromgeving, OpenU, is beproefd in het vakgebied Onderwijs- en Leerwetenschappen. Hiervoor zijn bestaande cursussen van de Master opleiding Onderwijswetenschappen herontworpen met het oog op flexibele uitlevering. Naast bestaande 'formats' zoals cursussen en open educational resources (OER), zijn nieuwe, doelgroepspecifieke formats ontwikkeld zoals leertrajecten, online masterclasses, domeinportalen en onderzoekscommunities.

De gerealiseerde implementatie van het integratiemodel toonde dat het goed mogelijk is een online leersysteem te ontwikkelen dat de concepten van elektronische leeromgevingen, sociale netwerksites en persoonlijke leeromgevingen verenigt.

De overgang naar een model dat de volwassen lerende centraal stelt, heeft uiteraard gevolgen voor ontwerp en uitlevering van cursussen en programma's. Het betekent dat onderwijsinstellingen ook de gereedschappen (tools) aan docenten en medewerkers beschikbaar moeten stellen om efficiënte, duurzame oplossingen te creëren. De tweede ontwerpvraag in dit proefschrift richt zich dan ook op efficiënte ondersteuning van de onderwijsorganisatie in dit opzicht. Deze vraag staat centraal in de hoofdstukken 4 en 5.

In hoofdstuk 4 wordt verder ingegaan op het concentrische cirkels model als uitwerking van de nieuwe bedrijfsstrategie van de OUNL. Dit model verdeelt de populatie volwassen lerenden in afzonderlijke doelgroepen. Elk van deze doelgroepen kent een eigen leervraag en vereist een hierop afgestemd onderwijsaanbod. Om docenten, belast met de ontwikkeling van een doelgroepspecifiek onderwijsaanbod, te kunnen ondersteunen in deze taak, is de volgende ontwerpvraag geformuleerd: *kunnen wij een systeem ontwikkelen voor efficiënte ontwikkeling en uitlevering van online cursussen die voldoen aan de eisen van het concentrische cirkels model. i.e. naar verschillende doelgroepen gepersonaliseerd kunnen worden?*

Ter beantwoording van deze vraag is een nieuwe auteursaanpak ontworpen met als uitgangspunt het ontwikkelen van flexibele cursussen die eenvoudig naar verschillende doelgroepen kunnen worden gepersonaliseerd (i.e. gesegmenteerde personalisatie), zowel met betrekking tot leeractiviteiten, leermaterialen als diensten. Als conceptueel kader voor het uitwerken van deze aanpak is IMS LD gebruikt, omwille van pedagogische expressiviteit, ondersteuning van verschillende rollen voor lerenden benodigd voor gesegmenteerde personalisatie, en omwille van aanwezige expertise met deze specificatie (zie hoofdstuk 2). Hierbij is tevens getracht om een aantal algemeen erkende problemen met IMS LD auteurstools te ondervangen: (1) van auteurs gevraagde kennis van IMS LD, (2) het niet kunnen aanpassen van het learning design in runtime en (3) het ontbreken van een snelle preview van het learning design in de runtime omgeving.

De ontwikkelde auteursaanpak kenmerkt zich door het gebruik van sjablonen die (1) complexiteit voor auteurs verminderen door substantiële delen van het learning design te standaardiseren en voor auteurs te verbergen, (2) een LD-auteurstool en LD-afspeler integreren, met de mogelijkheid voor auteurs om snel tussen auteursomgeving en runtime omgeving te schakelen en (3) een eenvoudige, taakgerichte personalisatie functionaliteit bevatten. Om deze aanpak te instrumenteren zijn zowel een toegespitste IMS LD editor (niveau A) als een IMS LD speler ontwikkeld als applicatie binnen de OpenU leeromgeving.

Deze nieuwe auteurs- en uitleveromgeving is beproefd in het vakgebied Onderwijs- en Leerwetenschappen van de OUNL. Van mei 2011 tot februari 2014 zijn in totaal 59 online cursussen ontwikkeld en uitgeleverd op basis van de geschetste aanpak. De aanpak was efficiënt, aangezien het ontwikkelen van een flexibele cursus conform het concentrische cirkels model in feite niet meer was dan het ontwikkelen van een 'reguliere' cursus, behalve dat op een bepaald moment leeractiviteiten expliciet moeten worden toegewezen aan de onderscheiden doelgroepen. Onze implementatie liet ook zien dat het mogelijk is de muren te slechten tussen IMS LD ontwikkel- en uitleveromgeving. Empirische gegevens staven vervolgens de ontwerpeis het learning design in runtime aan te kunnen passen: 59% van alle leeractiviteiten zijn aangepast of zelfs aangemaakt na start van de cursussen.

In hoofdstuk 5 staat het zogenaamde *provisioning* proces centraal. Dit proces is gericht op het beschikbaar stellen van diensten en faciliteiten aan de verschillende deelnemers in onderwijs- en leerprocessen. Voor onderwijsinstellingen die verschillende doelgroepen lerenden willen bedienen met een verscheidenheid aan online diensten in verschillende combinaties is een efficiënte provisioning aanpak vereist. Handmatig toegangsbeheer tot online diensten is veelomvattend, complex en foutgevoelig. Het provisioning proces vereist bovendien een robuuste aanpak om redenen van duurzaamheid, aangezien uit te leveren diensten en faciliteiten, alsmede de institutionele regels hieromtrent, aan verandering onderhevig zijn.

Ter ondersteuning van uitlevering van de diverse online cursusmodellen, zoals aangeboden via de OpenU leeromgeving, is een drietal online provisioning regels geïdentificeerd: (1) *toegangsregels*, die beschrijven tot welke cursus(sen) toegang verschaft moet worden en met welk toegangsniveau, (2) *inschrijfrechtregels*, die aangeven voor welke cursus(sen) en met welk toegangsniveau een lerende zich mag inschrijven en (3) *faciliteitenregels*, die specificeren welke online en/of fysieke faciliteiten samen met een inschrijving meegeleverd moeten worden. Vervolgens zijn eisen opgesteld voor een regel gebaseerd educatief provisioning systeem (EPS), en is een conceptueel model ontwikkeld rond het concept van course access levels (CALs). CALs zijn uitlevervarianten van een cursus, toegespitst naar specifieke doelgroepen, die variëren in toegang tot leeractiviteiten, leermaterialen en beschikbare diensten.

Het EPS-model is geïmplementeerd als een back-end applicatie binnen de OpenU leeromgeving. Deze applicatie vervult een drietal hoofdfuncties:

1. definiëren van één of meer CALs voor een (online) cursus;
2. koppelen van provisioning regels aan een CAL;
3. verwerken van provisioning regels en beschikbaar stellen van gebruikers provisioning informatie aan applicaties binnen de e-learning infrastructuur.

Om het robuust te maken is het EPS ontwikkeld als een servicelaag tussen administratieve systemen en de e-learning infrastructuur. Een applicatiespecifieke adapter is ontwikkeld om EPS provisioning informatie te vertalen naar de juiste toegangsrechten in de e-learning applicatie.

Het ontwikkelde EPS is een efficiënte provisioning oplossing gebleken. Het systeem maakt het mogelijk het volledige provisioning proces te beheren, terwijl een applicatie-specifieke adapter de specifieke toegangsrechten regelt.

Hoofdstuk 6 blikt terug op zowel de ontwikkelde modellen voor integratie, auteurs-proces en provisioning, alsmede de gerealiseerde implementaties. Beide hoofd-ontwerpvragen in dit proefschrift kunnen bevestigend worden beantwoord: (1) de OpenU implementatie integreert institutionele, sociale en persoonlijke contexten voor leren in één omgeving, en stelt lerenden in staat zich naadloos te bewegen tussen deze contexten; (2) er is een efficiënte aanpak ontwikkeld voor ontwikkelen en uitleveren van flexibele cursussen. Voorts kan uit onze OpenU implementatie worden geconcludeerd dat een generiek, uitbreidbaar sociaal platform, zoals Liferay, geschikt is voor de implementatie van een nieuwe generatie (geïntegreerde) leeromgevingen.

Het integratiemodel alsmede de implementatie van dit model staan toekomstige uitbreiding toe. Uitbreiding van de institutionele context met andere institutionele aanbieders vergroot de keuzemogelijkheid voor lerenden. De gerealiseerde implementatie is hiernaast voldoende open met betrekking tot het importeren en exporteren van data en functionaliteit. Voor toekomstige implementaties wordt voorgesteld om mogelijkheden van het onlangs door het Advanced Distributed Learning (ADL) initiatief gelanceerde eXperience API (XAPI) te onderzoeken.

Gesegmenteerde personalisatie, een centraal thema in dit proefschrift, is mogelijk gemaakt door het gebruik van CALs, ondersteund door zowel het auteurssysteem als het provisioning systeem. Dit concept biedt de mogelijkheid om cursussen en de inrichting van (institutionele) persoonlijke leeromgevingen te differentiëren naar verschillende doelgroepen. Voor een geavanceerder niveau van personalisatie *binnen* CALs stellen wij voor de toekomst het gebruik van IMS LD niveau B concepten voor, waarbij de auteursomgeving rekening houdt met uiteenlopende expertiseniveaus van auteurs.

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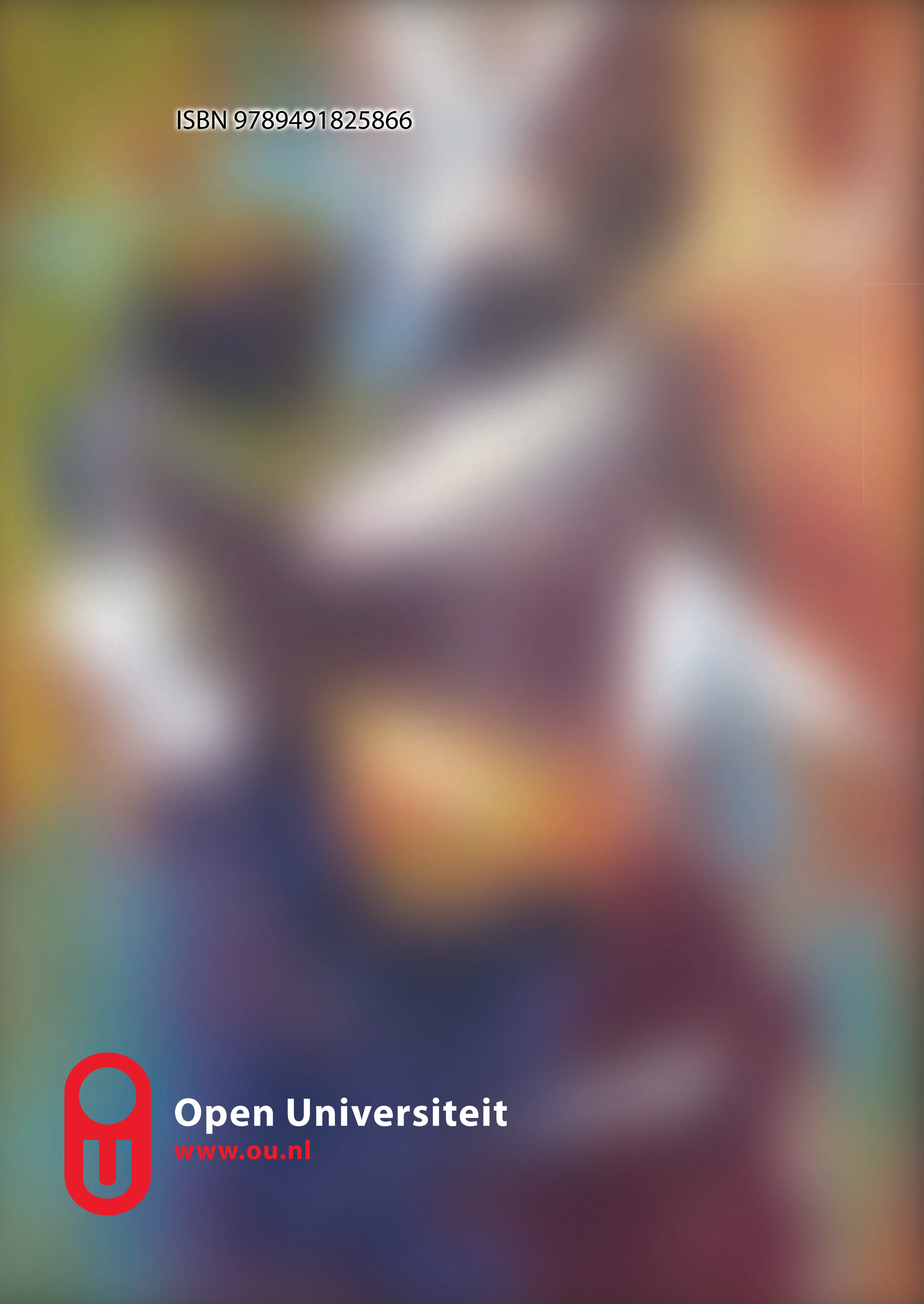

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