European Lifelong Competence Development: Requirements and Technologies for Its Realisation

Eelco Herder, Arne Koesling, Daniel Olmedilla
L3S Research Center
Germany
{herder,koesling,olmedilla}@l3s.de

Hans Hummel
Open Universiteit
The Netherlands
Hans.Hummel@ou.nl

Judith Schoonenboom
Universiteit van Amsterdam
The Netherlands
j.i.schoonenboom@uva.nl

Ayman Moghnieh
Universitat Pompeu Fabra
Spain
aymanmoghnieh@yahoo.com

Luk Vervenne
Synergetics
Belgium
Luk@synergetics.be

Abstract – *In the TenCompetence project, we aim to address the growing need for lifelong development with an open source framework for competence development programmes. We envisage that the framework will be used for formal, non-formal and informal learning activities; learning units will be created and shared in a distributed manner in learning networks, and peer-to-peer learning activities will be highly important. In this paper, we give an overview of the requirements and techniques needed to achieve this goal. Methods for learner assessment are needed for individualizing learning programmes. The system should provide functionality to position the learner in and around learning programmes, and to generate personalized navigation paths that match the learner goal; in addition, learners should be able to organize their learning process and to communicate. We discuss several existing tools and standards that may be used as a basis for the framework.*

Keywords: lifelong learning, Competence Development Programmes, methodology, positioning, navigation, learner support, assessment.

1 Introduction

In our largely knowledge-based society there is a growing need for continuing professional development, in order to deal with the evolving character of professional knowledge and technologies. Currently, education at high schools and universities is considered just the mere beginning of a process of *lifelong learning* [3]. Those learning activities that are aimed at maintaining or increasing the level of a worker's *competence* are generally called *competence development programmes.*

Competence development is generally not limited to formal learning activities that lead to certificates or degrees; many lifelong learning activities can be characterized as *non-formal learning* – on-the-spot training, possibly offered by peers –, or as *informal learning* – the acquisition of knowledge and skills by practice rather than intentional learning [4]

In order to support these activities, a technological infrastructure is required for storing, organizing and sharing the various bodies of knowledge; in addition, this infrastructure should provide lifelong learners with learning units that fit their individual background knowledge, learning objectives, and other needs.

Technological support for learning activities is not a new concept; a substantial amount of research has been carried out in the field of *adaptive and intelligent Web-based educational systems* [2]. However, the broader field of competence development poses several additional challenges and requirements, as compared to mere educational programmes.

In this paper we provide an overview of requirements and technologies needed for the realisation of lifelong competence development programmes. The aim of the European Integrated Project TenCompetence is to target these issues by integrating and extending existing models and systems into a common open source infrastructure.

The remainder of this paper is structured as follows. In the following section we introduce the concepts of competence and competence developments programmes (CDPs) in more detail. In the third section we discuss the need for a learner assessment service, and various approaches toward learner assessment. The fourth section describes the core services that need to be provided by the TenCompetence infrastructure: learner positioning in a learning programme, navigation support that matches the learner's individual needs, and general support for organization activities and communication. In section five we discuss several existing tools and standards, and indicate to what extent they would fulfil our requirements. The paper ends with some concluding remarks.

2 Competence Development

In this section we briefly discuss the concept of competence, and provide our vision on competence development programmes for lifelong learners.

2.1 Competence

Cheetam and Chivers [3] define competence as 'overall, effective performance within an occupation, which may range from the basic level of proficiency to the highest levels of excellence'. A key observation from this definition is that the concept of competence relates three different dimensions:

- a person's *competencies*[1] - knowledge, skills, attitude, or any psychomotor or mental activity which may require mastery [3][10];
- an *occupation*, which may range from hobbies and sports to professions; we prefer to use the more general term *context* instead;
- the *proficiency level* of a person with respect to a context; proficiency may be expressed by a collection of skills, by some demonstration of appropriate behaviour in the context, or by competences in related contexts.

As persons may have various occupations, they may have various levels of competence for each occupation. For example, John might excel in his job as a dentist, but his qualities as an orthodontist are mediocre. Yet, there is an overlap in the knowledge and skills required for both professions, and skills learned in the former profession might increase competence in the latter profession.

2.2 Competence Development Programmes

We define Competence Development Programmes (CDPs) as formal, non-formal, or informal collections of learning activities and units of learning, which are used to build competence in a certain discipline or job. The learning activities and units of learning are relatively independent from each other – as compared to a unit of learning, which is a tight integration of learning activities. Depending on the competencies to be built, these programmes can be small or quite extensive.

We envisage that CDPs can be greatly facilitated by so-called *learning networks* – people, institutions, learning objects and autonomous agents, which are connected by ICT networks [10]. Within these networks, learning units can be created and shared in a distributed, self-organized manner. In a sufficiently large learning network, the various bodies of knowledge existing in the group allow for the creation of learning programmes that fit an individual learner's need. These programmes may include formal programmes offered by institutions, but may just as well be the result of peers exchanging knowledge with one another.

In the field of Web-based educational systems technologies for *adaptive group formation*, *peer help* and *adaptive collaboration support* are well-researched areas [2]. These forms of group learning allow learners to discuss with one another, to find the most competent peer to answer a question, share learning routes, provide useful annotations and links, and to stimulate one another. In the context of competent development programmes these ideas can be extended to professionals exchanging knowledge and instructing one another.

Clearly, if a learning network would mainly be based on self-organized, peer-to-peer networks, it would be hard to assess the quality of any competence development programme. For this reason, there is the need for a formal specification of the programmes, and assessment of their effectiveness. In the field of CDPs several specifications of curricula and training programmes exist [e..g 9]. One of the goals of the TenCompetence project is to find a mix between these formal learning programme specifications and experiences with informal (group) learning activities into a specification to guide lifelong competence development programmes, as envisaged in this section. The various aspects that are relevant to this goal are dealt with in the upcoming sections.

3 Assessment Service

Within a competence development programme, there are several points at which the learner's competence needs to be assessed. In order to ensure that the learning material can be adapted to the learner's capabilities and goals, it is necessary to assess the learner's *existing competence levels* upon entering a CDP. In a network like TenCompetence, assessment of prior competences is far more important than in standard formal education, as learners may enter the network at various moments within their learning career. Consequently, upon entering, their level of prior competences will be very diverse. As the learner proceeds through the CDP, so-called formative assessment is needed *to guide the learner*. Based on the results of interim assessments, the learner's personal CDP can be adjusted either by a tutor or by the system. Finally, so-called summative assessment is needed *to determine whether the learner has successfully proceeded* to a next proficiency level of the competence involved.

An important role in all three types of assessment will be played by the learner's *e-portfolio*, in which all kinds of evidence of the learner's achievements are collected, such as prior work, results of units of learning, papers and reflections. Parts of the e-portfolio may be constructed explicitly by the learner or the tutor; implicit (automated) distillation of evidence data – such as the content of written

[1] For sake of simplicity and due to the overload of the term competency, we will use skill as a synonym henceforth. We do acknowledge that the term skill only partially covers the concept of competency.

reports – into e-portfolio contents is an alternative strategy which may reduce an enterprise's need to continuously track the human factor.

In addition to e-portfolios, various other forms of assessments can be thought of. Learners may engage in some form of self-assessment, or the assessment can be performed by a tutor or through online tests.

The challenging task for us is to formulate requirements for the development of efficient and effective assessments within a CDP, and more specifically requirements on e-portfolios.

4 Core CDP Services

As all learners who enter a network of lifelong learning have their own expertises, goals and learning styles, it is a challenge to match the individual characteristics with the possibly vast variety of learning content. One of the main goals of the system is to provide learners with selections of material that fit their background and learning goals, and not to force them to follow one predefined programme for each competence that they want to achieve. This implies that the system should be able to generate individualized programmes, and to support the learners in their progress – or at least to foster the support for the professional tutors.

To be capable to respond to these tasks, a number of core services is defined that are specific to the needs of competence development:

- a *positioning service*, which maps the learner's background onto a learning programme;
- a *navigation service* that generates or adapts a programme, based on the learner position;
- a *learner support service*, which provides a framework for the organization of learning activities and communication with one another.

These services will be explained in more detail in the remainder of this section.

4.1 Positioning Service

As multiple providers, and even learners, are expected to contribute to the network, mechanisms are needed to determine where learners can be positioned in this network [13]. *Positioning* is the process of mapping learner characteristics – as received by an e-portfolio or by a personal competence development plan – onto learning programmes, which consist of learning units in a learning network. These learner characteristics may include learner goals, prior knowledge and the interaction history. The position process should enable to select those learning units that are relevant to a learner's individual goal, and to leave out learning units that are not relevant, already known, or beyond a learner's current capabilities. In formally accredited competence development programmes, this step would provide obligatory items and formal exemptions; in informal programs, this step would generate recommendations. Such a service requires prior competence assessment, the creation and maintenance of e-portfolios and finally the allotment of learners to courses.

Considering the nature of the network envisaged, maintaining data on these characteristics and ensuring their integrity are difficult tasks. Several issues will need to be solved, like the selection of suitable approaches toward learner assessment, preferably as efficient and as autonomous as possible. A further issue is the mapping of the raw data from the user e-portfolios – which may contain lists of finished courses, their descriptions, questions asked and answers given – to a model of the learner in the learning environment.

We are currently exploring several fields to deal with the challenges given here. Various approaches can be thought of, including *content-based* techniques such as LSA, *usage-based* techniques such as clustering and stereotyping, *logical* representations and reasoning mechanisms, *collaborative filtering* and *Semantic Web* techniques.

4.2 Navigation Service

Once the learner has been positioned in a learning network, there is the need for an adaptive and flexible approach to provide the learners with means for orienting and navigating through a learning network's learning courses and units [12]. Predetermined fixed paths in accredited programmes restrict the possibilities of self-direction of the learner and are not necessarily the most appropriate sequences for the individual needs of a learner. Regarding non-accredited programmes on the other hand, the learner is on his own, which may quickly lead to frustration and drop-out, because of the lack of overview.

In order to cater the individual learner needs, the TenCompetence system will need to provide adaptive navigation support that puts the learner centre-stage. From the field of adaptive hypermedia [1] several personalization techniques can be borrowed. These include *individualized overviews* of the learning courses and units, and the learner's history; *relevancy indication* of internal or external links within the network; *guided tours* and *collaboratively* generated trails, *recommendations* and *annotations*.

4.3 Learner Support Service

The TenCompetence network will be particularly attractive to self-directed learners, who can plan themselves which learning programmes to follow, at what times, at which location, and with what speed. However, in particular in these kinds of non-accredited learning programmes, learners often lack a tutor to offer support, when needed.

Furthermore, the lack of feedback and interaction with peers may lead to motivation problems.

To address these issues, Kester et al. [7] proposes the following approach toward *peer-to-peer tutoring*: if a learner issues a content-related question to the system, the system will first try to find an appropriate answer in the existing resources, such as FAQs, forums and user-editable wiki pages. If the result would not sufficiently meet the learner's expectations, the learner could decide to ask help from a peer-tutor. It will be the system's responsibility to select the most suitable candidates. Ideally, a peer-tutor should be sufficiently experienced in the relevant field, but preferably not too far ahead of the learner; in this ideal situation both the learner and the peer-tutor can draw benefits from the interaction. Following the same principle, transient communities of peers interested in the same topic can be created, who can support and motivate one another. In addition, professional tutors can be contacted to further support the process.

5 Specification and Tools for CDPs

In order to allow wide adoption of the CDP standard, it is necessary to develop appropriate tools, or to adapt existing tools for the management and manipulation of such CDPs within the TenCompetence environment. The compatibility of *Free and Open Source Software* (FOSS) with interoperability standards and specifications is evaluated while seeking reusable components. In fact, the lack of information exchange between present-day e-learning systems highlights the need to adopt interoperability standards in future developments.

In principle, interoperability relies on a coherent set of e-learning specifications, which are formulated by bodies such as the IMS Global Learning Consortium Inc., in order to standardize and to facilitate the exchange of functionalities and resources.

5.1 Overview of Existing FOSS

During the last years, a number of e-learning design projects have yielded a set of specialized tools based on IMS Learning Design (LD) and Question & Test Interoperability (QTI) specifications [6], to promote coordination between distributed learning environments and content from multiple authors. These tools basically cover design-time editors that allow authors to construct CDPs and other related materials, as well as run-time players that dynamically provide learners with the appropriate resources and functionalities during learning activities. While a comprehensive overview of reusable e-learning tools and components is outside the scope of this paper, there are a number of published surveys and previous works that provide such overviews [5] [11].
In general, Griffiths et al [5], concluded that current FOSS authoring tools are scarce and not yet mature. Present-day, FOSS tools that rely on interoperability specifications resemble meta-tagging interfaces rather than authoring tools. In fact, Sayago [11] noted that the set of FOSS tools, created in compliance with IMS QTI specifications, tends to achieve low usability scores, mainly for not abstracting the specifications enough from their users. In contrast, a quick overview of commercial e-learning authoring and CDP management tools heavily suggests a much higher usability than FOSS.

In conclusion, any proper selection criteria of FOSS components must address both interoperability and usability simultaneously, since low usability of e-learning systems is among the principal reasons of failure due to the elevated drop-out rate that they can engender [8].

5.2 QAed for Managing Competences and CDPs

Interoperability and usability need not to be conflicting in e-learning applications. Sayago et al. have developed an authoring tool called QAed [11] to demonstrate how specifications can be implemented under a user-friendly interface. The QAed tool facilitates the creation and management of assessment repositories. It is based on a simplified version of IMS QTI specifications, known as QTI-Lite. This tool was produced for the purpose of creating an e-learning framework, and relies on a set of QTI-Lite Java libraries to provide an IMS specifications-compliant functionality for the construction of assessment contents. On the other hand, the QAed's interface hides the specifications and related technical terminologies from the authors, and provides additional structures and functionalities related to their needs.

The QAed tool is currently a standalone application and undergoing efforts are transforming it to an open-source plug-in for service oriented architectures. Since we expect that it will be fairly straightforward to map our future models of competences and CDPs into IMS format specifications, the QAed tool represents a strong candidate to handle the management of repositories of competences and CDPs.

6 Conclusions

The aim of the TenCompetence project is to provide a generic architecture for a European learning network, to develop a new form of education delivery that goes beyond course and program centric models, and to envision a learner-centred and learner-controlled model of lifelong learning.

The components introduced in this paper should ensure that the learner control does not come with the cost of extra responsibilities with regard to finding their own peers, discovering knowledge resources, or creating their own customized programmes; the system should provide

adequate means and adequate feedback for these meta-learning activities. The concepts are largely dependent on the learners' input, which includes keeping their e-portfolios up-to-date, participating in the various communications, and rating the available resources. In order to stimulate participants to carry out these activities, incentive mechanisms could be applied to render the learner's experience more profitable, pleasant and joyful.

References

1. Brusilovsky, P. Adaptive Hypermedia. *J. User Modeling and User-Adapted Interaction 11*. 2001, pp. 87-110.

2. Brusilovsky, P. & Peylo, G. Adaptive and Intelligent Web-based Educational Systems. *Intl. J. Artificial Intelligence in Education*. 2003, pp. 156-169.

3. Cheetam G. & Chivers, G. Professions, Competence and Informal Learning. Edgard Elgar Publishing Limited. ISBN: 1-84376-408-3. 2005.

4. European Commission. Lifelong Learning Practice and Indicators. *Commission Staf Working Document*. November 2001

5. Griffiths, D., Blat, J., Garcia, R., Vogten, H. & Kwong, K.L. Learning Design Tools. In *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training*, eds. Koper, R. & Tattersall, C. Springer Verlag, 2005, pp. 109-136.

6. IMS Global Learning Consortium Inc. Corporate Website, *available at* http://www.imsglobal.org/

7. Kester, L., Sloep, P., Brouns F., van Rosmalen, P., de Vries, F., de Croock M. and Koper, R. Enhancing Social Interaction and Spreading Tutor Responsibilities in Bottom-Up Organized Learning Networks. *Submitted to a journal*.

8. Miller, M.J. Usability in E-Learning. *Learning circuits*, Jan. 2005.

9. Norway Opening Universities. CDM - A Specification of Course Description Metadata. *Proposal 20*. October, 2004.

10. Open University of the Netherlands. Learning Networks – connecting people, organizations, autonomous agents and learning resources to establish the emergence of effective lifelong learning. *RTD Programme into Learning Technologies 2003-2008*. 2003.

11. Sayago, S., Martínez, J., Blat, J., García, R., Griffiths, D. & Casado, F. Design and evaluation of a simple eLearning authoring tool. *HCI related papers of Interacción. Springer Verlag*, 2006, pp. 81-89.

12. Tattersall, C. Van den Berg, B., Van Es, R., Janssen, J., Manderveld, J. & Koper, R. Swarm-based adaptation: wayfinding support for lifelong learners. *Proc. Adaptive Hypermedia 2004*. 2004, pp. 336-339.

13. Van Bruggen, J., Sloep, P., Van Rosmalen, P., Brouns, F., Vogten, H., Koper R. & Tattersall, C. Latent semantic analysis as a tool for learner positioning in learning networks for lifelong learning. *British J Educational Technology 35 (6)*. 2004, pp. 729–738