Transferring an Outcome-Oriented Learning Architecture to an IT Learning Game

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Abstract. Today's technology enhanced learning scenarios focus on outcome-oriented delivery of learning processes, contents, and services. Also, learners increasingly demand for innovative and motivating learning scenarios that match their habits of using media. The European project ICOPER researches outcome-oriented learning infrastructures for higher education contexts. The German BMBF-project SpITKom aims at transferring such approaches to basic qualification. Based on a Browser Game, it uses ICOPER's technical infrastructure which combines learning object metadata repositories, learning outcome repositories, learning design repositories and learner profile repositories. This paper initially depicts the technical infrastructure of an outcome-oriented learning scenario that was developed in the course of ICOPER and then outlines its transformation to the game-based learning approach as realized in the course of SpITKom.

Keywords: game based learning, outcome-oriented learning, interoperability, IT-knowledge

1. Outcome-Oriented Learning and Interoperability

One of the fundamental ideas of outcome-oriented education is to prepare students for the requirements of their professional life [13]. Rather than defining the resources to be used during the learning process, outcome-oriented learning scenarios focus on the results of the educational process, e.g. the skills and content students should be able to demonstrate.

Learning outcome orientation can be seen within a wider trend in educational technology recognizing the potential benefits of adaptivity. Paramythis and Loidl-Reisinger [9] argue that this "has been mainly driven by the realization that the ideal of individualized learning (i.e. learning tailored to the specific requirements and preferences of the individual) cannot be achieved, especially at a 'massive' scale, using traditional approaches" [p. 181]. Furthermore, the shift towards adaptivity has

been influenced by an increased awareness of learners' diversity which is a key consideration in both projects, ICOPER and SpITKom.

However, to be able to support such highly individualized learning scenarios, interoperability issues become important on the level of technical infrastructure: standards to describe learning outcomes, learner profiles, assessment items and learning materials are needed as well as tools to assess learner progress, maintain learner profiles, measure gaps and propose subsequent learning steps. Technical interoperability between different components of an overall learning delivery toolset is required in order to ensure seamless learning processes. Web-service based approaches help to simplify technical interoperability [14]. In the following, an exemplary application for outcome-oriented Learning will be described that was realized in the course of the European project ICOPER.

2. Learning Outcome-Orientation in ICOPER

The European ICOPER project [8] analyses and discusses state-of-the-art implementations of current standards as a base for the development of a comprehensive set of prototypes that support individual learning, teaching and authoring. In the course of ICOPER, the Open ICOPER Content Space (OICS) was developed which combines learning object metadata repositories, learning outcome repositories, learning design repositories and learner profile repositories [12].

Some of the standards the OICS works with comprise: *Sharable Content Object Reference Model (SCORM)* [1], *Learning Object Metadata (LOM)* [4] and *Open Archive Initiative's Protocol for Metadata Harvesting (OAI-PMH)* [6]. The *ICOPER Learning Outcome Definition (LOD)* is an application profile based on *IEEE Reusable Competency Definitions (RCD)* that can be used to create *Personal Achieved Learning Outcome (PALO)* profiles [7]. The OICS offers services that integrate concepts and data for the management of sharable educational resources as part of outcome-oriented learning processes (fig. 1).

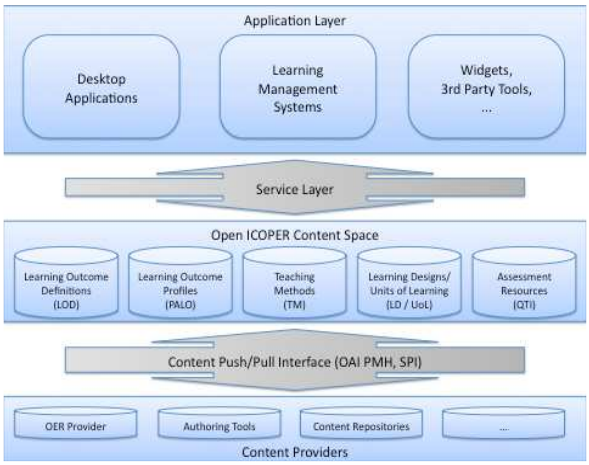

Figure 1: OICS Architecture

The service-based architecture of the OICS enables its use for innovative learning scenarios such as game-based learning for instance: it defines web-services for all relevant learning events. The OICS does not require its own user interface to be in place for the learner though. Especially in game-based learning, the user interface of a learning management system would reduce the game-experience. Also, the OICS services are neutral in terms of the didactic processes they support. They serve as backend to fine-grained learning activities such as selection of learning outcomes, delivery of learning content, assessment execution, or monitoring and recording of learning progress. Thus, they allow efficient integration of heterogeneous applications, such as learning games, authoring environments or assessment engines.

In many learning games, learning processes are implicitly encoded into the game which makes the use of learning standards hard [5]. The use of a component such as the OICS enables to clearly separate the game logic from the learning activities and to control learning activities according to the game flow. In the following we will describe how the OICS architecture was applied to a learning game in the context of SpITKom.

3. Applying the OICS to SpITKom

SpITKom (**Sp**ielerische Vermittlung von **IT**-**Kom**petenz) builds on the motivational potential (cf. [6], [2]) and the learning potential of collaboration and reciprocal apprenticeship [11] computer games provide. Its main focus is to support the acquisition of IT-knowledge thus preparing and enabling educationally disadvantaged learners to find an apprenticeship. Furthermore, SpITKom aims at supporting the acquisition of practical knowledge related to the building industry. Therewith, SpITKom targets at bringing forward the participants' professional and social competence. Also, by directing the game to the building industry, it is intended to support the development of a professional identity.

SpITKom has chosen to integrate the European Computer Driving License (ECDL)[1] as a commonly accepted standard that reflects and certifies up-to-date skills and knowledge in the use of a computer and common applications. In its standard version 5.0, the ECDL syllabus comprises 478 learning outcomes, organized in seven modules.

Graphically, SpITKom was aligned to Browser Games such as FarmVille[2] as a reference for accessible, easy to use game environments that offer high level stimuli as well as ongoing feedback [10]. The learning game (see fig. 3) guides the learner through building- and construction-projects. Its main intention is to bring the target group (learners difficult to reach) "in touch" with the integrated IT-knowledge. A more elaborate engagement, i.e. the actual learning, takes place within the IT-Café (see fig. 4). It provides access to (a) the ECDL questions, (b) comprehensive knowledge tests that indicate individual knowledge gaps and (c) the recommended ECDL learning materials that help to close these gaps.

[1] http://www.ecdl.org
[2] http://www.farmville.com

Figure 3: SpITKom Browser-Game (Draft Version)

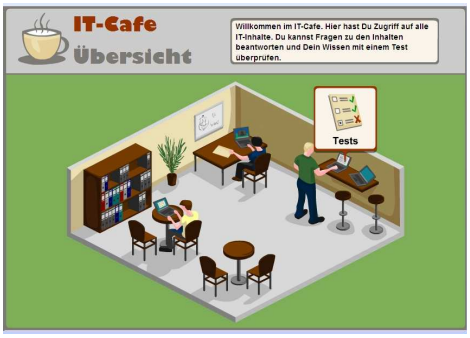

Figure 4: IT-Café (Draft Version)

Technically, the SpITKom system is partly based on the OICS platform. The SpITKom architecture comprises two main components: the front-end community platform and the OICS learning service component. In addition, the open source QTIEngine[3] is integrated to visualize and evaluate assessments. The community platform is based on the LifeRay open source community server. It contains the flash-based game front-end (fig. 3) and the CCT (Competency Checker and Trainer) which is realized through the IT-Café (fig. 4).

During the game flow, certain situations trigger learning processes. These are delegated from the game to the CCT. The CCT is the communication bridge between the game process and the learning infrastructure. It is responsible for translating the learning process requests triggered from the game into the web-service calls of the OICS infrastructure.

The CCT also associates the community user with the learning profiles (PALO) stored in the OICS. Thus, it can individualize learning processes by selecting learning outcomes, learning contents and assessment items that are useful for the current learner. Additionally, the CCT controls the QTIEngine: According to the user's profile it selects the assessments to be played. The QTIEngine's assessment rendering components are integrated into the front-end.

SpITKom's learning requirements can be matched to the repositories and services offered by the OICS infrastructure (see fig. 2 for an overview of the complete SpITKom architecture including the OICS components). In this architecture, the OICS serves as a backend repository that encapsulates all contents and results relevant for the learning. Items of the ECDL syllabus can be represented as LODs stored in the learning outcome repository. ECDL learning contents are realized as SCORM units stored in the OICS content repository. ECDL tests are stored in the QTI format within the OICS assessment repository. The individual tests are played using the QTIEngine. Assessment results delivered from the QTI-engine are stored back into the profile repository in the PALO format.

[3] http://www.qtitools.org/landingPages/QTIEngine

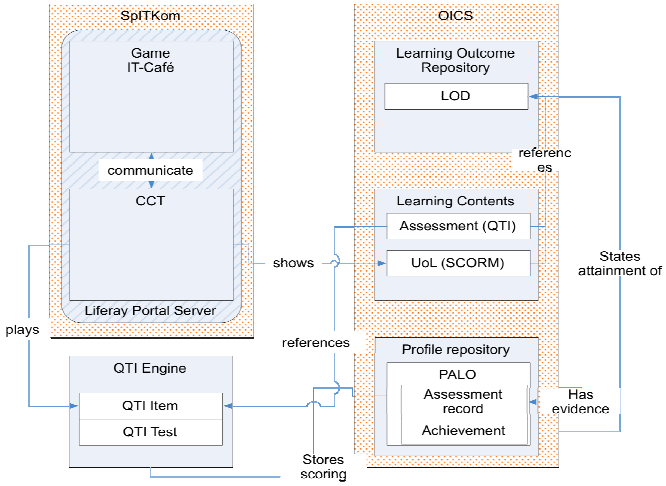

Figure 2: OICS infrastructure as applied to SpITKom

In the course of the game, test items related to IT-Knowledge (ECDL) are displayed to the user. The questions are rated 1 (easy) to 3 (difficult). Depending on the learner's performance (right/wrong), the system's core backend component (CCT) chooses the follow-up question in an adaptive manner in order to rate the learner's knowledge. As technically provided by the OICS, SpITKom matches the ECDL learning outcomes against the learner's concrete abilities. This way, it analyses the learner's needs and offers questions and *Units of Learning* in the sense of concrete, contextualized units of education or training [3] that can each be traced back to a single learning outcome. The answers of learners are collected and stored back in the learner's profile.

4. Conclusion & Outlook

In this paper we have described SpITKom, a Browser Game designed to support the acquisition of IT knowledge. In order to support individualized learning and to enable technical interoperability between different components of an overall learning delivery toolset, SpITKom has implemented outcome-oriented learning and assessment components based on the ICOPER infrastructure (OICS). Thus, the solution offers all technical advantages of re-usability and integration inherent to standardized components.

An overall evaluation of the prototype with particular focus on the educational outcomes of the game is planned for early 2012. This evaluation will scrutinize (a) the effects of outcome-oriented delivery of content and services on the individual learning processes and (b) the learning outcomes. Besides, it will be of particular interest to evaluate the general capacity and motivation of learners (i.e. learners difficult to reach) to take over responsibility for their individual learning and respectively the corresponding learning outcome which is enabled by the transformation of the OICS to game based qualification. The results of this study will be published in due course.

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