Traceable Pedagogical Design Rationales for Personalized Learning Technologies: An Interoperable System-to-System Approach

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ABSTRACT

Although a large number of e-learning systems for individual learning support exist today, many of them still deal with pedagogical issues in an isolated way. In contrast, intertwining interactive system features with educational concepts allows pedagogical designs that may be considered according to their educational rationale. However, pedagogical approaches also do not provide requirements for technologies; they rather consider tools and features as predefined design parameters. Taking an interoperability point of view allows focus on the interaction between the pedagogical and the technological systems. By interpreting technology and didactic approaches as systems and ensuring their interoperability, educators are able to adapt learning experiences and technological features in a way that the overall learning system becomes personalized. A key element of the described work is an architecture that captures the design elements from both progressive education focusing on individual learning support, and the enabling web-based e-learning technologies.

Keywords: Adaptation, Architecture, e-learning, Interoperability, Progressive Education

INTRODUCTION

Today, e-learning systems are developed to support the independent and individual acquisition of knowledge (Friedman & Deek, 2003). Individual and group learning processes may be facilitated through dedicated e-learning designs and implementations (Aqda, Hamidi & Ghorbandorjnejad, 2011, Auinger & Stary, 2005). This includes didactic designs according to pedagogical objectives, as well as technological designs. However, recent research (still) reveals a gap between the feature-oriented approach to e-learning software development, and education viewing technology as a black box (cf. Casanova, Moreira & Costa, 2011).

DOI: 10.4018/IJPOP.2014070102
Designing and developing an e-learning system requires a team of developers that is not only capable of producing software, but needs to “be aware of process of curriculum development, technical pedagogical knowledge, (TPCK), content knowledge, the place for designing and delivering the course, the learners.” (Assareh & Hosseini Bidokht 2011, p.792). Although a large number of different pedagogical approaches have been developed so far, educators still need to acquire know how on software development to design a learning support system that grounds technological features on reflected didactic instruments (cf. Anderson, 2004, Pan et al., 2010). In the following an approach to bridge conceptual gaps between technology developers and educators is developed for designing individual learning support systems in a mutually informed way. It is based on identifying interoperable components that may be arranged according to certain situational contexts and designer needs.

Interoperability focuses on the interface and interaction between two and more independent systems that together form a larger system (Naudet et al., 2010; Guédria & Naudet, 2014). Although these system elements are not dependent on each other, all elements contribute to a greater common functionality of the larger system. Integrated systems, in contrast to interoperable systems, have a functional dependence, where the entire system fails as soon as a single element fails. Hence, in an integrated system the sub-systems are not independent. Interoperable systems are contrary to compatible systems, as these latter types of systems do not interfere with each other and therefore do not contribute to some higher larger system functionality or goal (Panetto, 2007).

In order to support the structured implementation of pedagogical approaches in e-learning, explicit representations of didactically valid designs and software features allow for transparent mutual relationships. While multiple approaches exist for the representation of such systems, to reach our objectives an approach providing an overview of modules and interfaces on both levels, the e-learning/pedagogy level and the software technology level, is required. We make use of an Enterprise Architecture language, as it promotes a layered and contextual perspective on usage- and stakeholder-relevant processes supported by software technologies. ArchiMate (www.archimate.org; Iacob et al. 2012; Jonkers and Proper, 2009) allows the modelling of an abstract architecture pinpointing essential system parts and their relationships, including their refinement from domain or business structures to system functions to be executed by IT. Moreover, ArchiMate allows inclusion of interoperability aspects (Guédria et al. 2013).

In the following sections we introduce an interoperability model that has been designed to support educators in the structured and context-aware development of web-based, personalized e-learning systems. The approach is based on interoperable design elements that encode progressive education concepts for informed personalization. First, we give definitions of core concepts used throughout this paper. This section is followed by a discussion of State-of-the-Art features and systems for technology-supported learning. Then, we review recent architectures of Learning Content Management Systems (LCMS) and reveal their limitations taking into account pedagogical systems and design elements. After elaborating the requirements from the pedagogical perspective, we show various degrees of support, ranging from integrated to compatible systems, and exemplify their design benefit for a specific pedagogical approach. It is based on building systems, and using these systems for creating content according to educational principles, such as finally exemplified for a selected pedagogical approach to personalized learning.

CONCEPTS

In this part we address all core concepts relevant to this contribution. First, we elaborate on the specific type of socio-technical system under consideration, as it constitutes the universe of
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