Applying the Widget Paradigm to Learning Design: Towards a New Level of User Adoption

Bernd Simon[1], Michael Aram[1], Frans Van Assche[2], Luis Anido Rifon[3], David Griffiths[4], and Manuel Caeiro Rodríguez[3]

[1] Knowledge Markets Consulting, Siebensterngasse 31/12, A-1070 Wien, Austria
{bernd.simon,michael.aram}@km.co.at
[2] University of Leuven, Computer Science Department, Belgium
frans.vanassche@cs.kuleuven.be
[3] Universidad de Vigo, Campus Universitario de Vigo, As Lagoas, Marcosende, ES-36310 Vigo
{luis.anido,mcaeiro}@det.uvigo.es
[4] University of Bolton, Deane Road, BL3 5AB Bolton, United Kingdom
dai.griffiths.1@gmail.com

Abstract. Researching the sharing of learning designs is a well-established domain within the technology-enhanced learning research community. However, until now tools supporting educational modelling languages such as IMS Learning Design have reached a wide adoption in today's school practice. Following a design science research methodology we report on the design, implementation, and evaluation of a novel tool referred to as "Composer". The Composer supports the design of learning activities and has been developed according to design principles such as (a) interoperability between design-time and run-time systems based on the W3C Widget Standard, (b) inclusion of artefact types beyond content such as tools, people and events, (c) a user-friendly authoring environment. A first evaluation of the proof-of-concept implementation suggests that the tool is easy-to-use and provides added value for teachers when it comes to reflecting about the design of learning activities.

Keywords: Learning Design, Educational Modelling, W3C Widgets, Mashups, Wookie, Design Science.

1 Motivation and Methodology

The primary role of any instructional agent such as a teacher, is to stimulate the performance of learning activities that will gradually result in the attainment of the learning outcomes [1]. As a consequence learning design has always been of a particular interest to the educational domain. [2] provide an overview of learning design authoring software that aims to simplify the learning design process. [3] provide a graphical user interface for designing learning activities based on IMS Learning Design. Evaluation of the latter revealed the disconnection between the design tool and the runtime system as one major problem with respect to user acceptance [3]. Until now,

D. Hernández -Leo et al. (Eds.): EC-TEL 2013, LNCS 8095, pp. 520–525, 2013.

tools supporting educational modelling languages have not reached wide adoption [2], [4], [5]. In the following, learning design is meant as the preparation of a unit-of-learning (e.g. course, lesson) and includes the definition of learning outcomes, the selection of learning resources, and the sequencing of measures [1], [4].

We focus on (blended) learning environments of the school sector. Although evidence suggests that ICT can have a positive impact on the expansion of learning opportunities [6], [7], there is still a significant number of schools in Europe that lack sufficient computer equipment [7]. At the same time the adoption of ICT also varies between subjects [8].

This research effort is tackling the learning design issue by applying a design science research methodology (DSRM) [9] on the problem. Design science research is a research paradigm in which the researchers try to answer questions to relevant problems via the creation of innovative artefacts [10], [11]. A number of efforts have been made to describe and guide construction-oriented research processes [12], [13], [14]. Based on this the DSRM identifies six activities [9], i.e. problem identification and motivation, objectives for a solution, design and development, demonstration, evaluation, and communication.

This paper is structured accordingly. While Section 2 presents requirements and reflects them in the context of related work, Section 3 presents our proposed solution relying on a widget-based architecture. In Section 4 the paper concludes with preliminary findings of our evaluation.

2 Requirements and Related Work

Our proposed solution is centred on the design and facilitation of Learning Activities. We define our key concepts as follows: a *Learning Activity Design* (LAD) describes a discrete session of Learner interactions, including potential Learning Resources to be used, in order to achieve educational outcomes. We adopt a broad view of the term "*Learning Resource*" as to comprise Content, Contributors, Events and Tools and assume that all artefacts that are meant to become part of the final learning experience are represented as, or delivered through, widgets. A conceptually similar model is proposed by the Simple Learning Design 2.0 [4] specification, where a learning design is manifested in a so-called scenario, which is composed of learning activities that can also include learning objects.

Our relevant stakeholder roles include *Learners*, *Teachers*, and *Pedagogical Coordinators*. A Pedagogical Coordinator inspires other Teachers to adopt pedagogical innovation mediated by LADs in a learning context that aims to serve Learners in attaining learning outcomes.

Driven by an analysis of the educational context we have identified the following requirements – very similar to those identified by [15] for learning design repositories. Pedagogical Coordinators demand means to create and reuse LADs and share these in order to inspire Teachers. While [15] identify the need for downloading learning designs, we go further by proposing a complete architecture for the exchange of learning designs. Teachers need to easily find and assess a LAD in order to make the associated Learning Resources available to Learners. To support the exchange of LADs across systems the systems involved need to be interoperable. *Interoperability* is referred to as the ability of systems or components to use information that has been exchanged [16]. Research distinguishes between interoperability on the object, referring to a proper use of the information provided – and interoperability in communication, referring to an agreed communication protocol between systems [17]. These two aspects of interoperability translate into a requirement for making LADs re-useable in different technical contexts as well as for agreeing on communication protocols.

3 Proposed Solution: A Widget-Based Architecture

We have designed an architecture that consists of the following components: A *Widget* is a packaged web application [18] that is designed to be easily distributed and embedded within varying contexts (e.g. within a portal-style mashup, on a mobile phone, etc…). Widgets rely on open standards with respect to both their representation format and their communication protocols.

The *Widget Store* is a software component that is built on the Apache Wookie and EDUKApp technologies [19]. It supports the uploading, tagging, and searching for Learning Resources and LADs in the form of Widgets. The *Composer* supports Pedagogical Coordinators and Teachers in designing Learning Activities, and augmenting them with Learning Resources.

A *Widget Run-time Environment (RTE)* acts as the "entry point" for end users and is a configurable software container that provides an environment allowing users to identify and add their Widgets and to integrate them in order to meet the educational objectives of a Learning Activity. Typically, a Widget RTE connects to a Widget Store to provide users with an integrated experience when selecting and instantiating widgets [20]. Examples include mashup engines like Apache RAVE as well as Widget-enabled learning management systems like Moodle and DotLRN.

3.1 Representing Learning Designs via Widgets

In the following we describe our layered approach to representing LADs, that follows the "web best practices" of *progressive enhancement* and the *rule of least power* [21]. Consequently, when entering a higher level, interoperability decreases, while functionality increases. At the lowest layer we render a LAD as HTML. Hence, the fundamental (narrative) information of such a guide is represented as a web document, thus can be viewed in any standard web browser, or processed otherwise by third-party applications.

Packaging this LAD as a W3C Widget represents the second layer, which allows teachers to (easier) use the LAD in various manners, e.g. instantiate it in their Widget RTE, view it offline on a phone, or publish it in a Widget Store. At these two levels the LAD already provides added value to the teacher both when preparing the learning activity and when it takes place.

However, many useful LADs will go beyond mere textual descriptions and will require actually useful resources (e.g. Applications, Content). Hence, the technology shall support the Teacher in augmenting the (virtual) learning environment with these resources. We therefore progress further in the functional enhancement by "transforming" the instantiated LAD Widget into a mashup. Technically, to this end our approach utilizes a client side cross-context communication channel (based on pmrpc [22]) to transmit a description of the additional Learning Resources required. As we consider all resources to be delivered via Widgets, we represent the resources required by the LAD in the form of an mashup description based on the Open Mashup Description Language (OMDL)[1]. Finally, the RTE instantiates all the Widgets required for conducting the learning activity that is described by the LAD Widget.

3.2 The Composer: Authoring Environment for Widget-Based LADs

The Composer is supposed to provide Pedagogical Coordinators and Teachers with means to compose and re-use Learning Activities and augment them with Learning Resources. We interpreted this process as Widget aggregation [21]. An important use case in the context of the Composer is the "typical usage scenario for learning resources" [17], which includes the discovery, repurposing, and re-publishing of a LAD. When repurposing the LAD the Teacher aggregates Widgets. The result of this mashup activity is a personalized LAD in the form of a LAD Widget generated using Xocp[2]. For interoperability, the Composer has been implemented as a highly embeddable web application, i.e. we allow its seamless integration via the IMS Learning Tools Interoperability (LTI)[3] protocol and implemented a responsive user interface using Bootstrap[4]. Moreover, a "Composer Widget" that implements a simple wrapper mechanism makes the application also accessible via the Widget Store.

4 Evaluation

At the time of writing 19 small-scale evaluation activities of the proposed solution have been carried out. Early evaluation activities mainly consisted of open expert interviews from which a better understanding of the problem definition was derived. At a later stage these activities were used to iteratively revise the requirements. The evaluation events mostly involved pedagogical experts. Early evaluations were documented in the form of action logs resulting in concrete changes to requirements. In the case of the Composer the main findings relate to: (a) a simple user interface, (b) private areas within the collaborative, wiki-style tool, and (c) better integration with mobile devices like tablets.

1 `http://omdl.org/`
2 `http://wiki.tcl.tk/28538`
3 `http://www.imsglobal.org/lti/`
4 `http://twitter.github.io/bootstrap/`

Acknowledgements. This article is the result of the iTEC (Innovative Technologies for an Engaging Classroom) Project supported by the European Commission's FP7 Programme (Grant agreement Nº 257566).

References

[1] Koper, R., Bennett, S.: Learning Design: Concepts. In: Adelsberger, P.D.H.H., Kinshuk, P., Pawlowski, P.D.J.M., Sampson, P.D.G. (eds.) Handbook on Information Technologies for Education and Training, pp. 135–154. Springer, Heidelberg (2008)

[2] Derntl, M., Neumann, S., Griffiths, D., Oberhuemer, P.: The Conceptual Structure of IMS Learning Design Does Not Impede Its Use for Authoring. IEEE Transactions on Learning Technologies 5(1), 74–86 (2011)

[3] Neumann, S., Oberhuemer, P.: User Evaluation of a Graphical Modeling Tool for IMS Learning Design. In: Spaniol, M., Li, Q., Klamma, R., Lau, R.W.H. (eds.) ICWL 2009. LNCS, vol. 5686, pp. 287–296. Springer, Heidelberg (2009)

[4] Durand, G., Belliveau, L., Craig, B.: Simple Learning Design 2.0. In: IEEE 10th International Conference on Advanced Learning Technologies (ICALT) 2010, pp. 549–551 (2010)

[5] Durand, G., Downes, S.: Toward Simple Learning Design 2.0. In: 4th International Conference on Computer Science & Education, ICCSE 2009, pp. 894–897 (2009)

[6] Core ICT Indicators 2010. International Telecommunication Union (ITU)

[7] Technology, Broadband and Education Advancing the Education for All Agenda - A Report by the Broadband Commission Working Group on Education. International Telecommunication Union (ITU)

[8] PISA, Results: Students On Line Digital Technologies and Performance. OECD (2009), http://www.oecd.org/pisa/pisaproducts/pisa2009/48270093.pdf

[9] Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems 24, 45–77 (2007)

[10] Hevner, A., Chatterjee, S.: Design Research in Information Systems: Theory and Practice. Springer (2010)

[11] March, S.T., Smith, G.F.: Design and Natural Science Research on Information Technology. Decision Support Systems 15(4), 251–266 (1995)

[12] Hevner, A.R.: A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems 19(2), 87 (2007)

[13] Vaishnavi, V.K., Kuechler, W.: Design Science Research Methods and Patterns: Innovating Information and Communication Technology, 1st edn. Auerbach Publications (2007)

[14] Takeda, H., Veerkamp, P., Tomiyama, T., Yoshikawa, H.: Modeling Design Processes. AI Mag. 11(4), 37–48 (1990)

[15] Sampson, D.G., Zervas, P., Sotiriou, S.: From Learning Objects Repositories to Learning Design Repositories: The COSMOS Learning Design Repository. In: 2011 11th IEEE International Conference on Advanced Learning Technologies (ICALT), pp. 285–289 (2011)

[16] IEEE Standard Computer Dictionary. A Compilation of IEEE Standard Computer Glossaries (1991)

[17] Van Assche, F., Duval, E., Massart, D., Olmedilla, D., Simon, B., Sobernig, S., Ternier, S., Wild, F.: Spinning Interoperable Applications for Teaching & Learning using the Simple Query Interface. Journal of Educational Technology & Society 9(2), 51–67 (2006)

[18] Packaged Web Apps (Widgets) - Packaging and XML Configuration (Second Edition) W3C Recommendation (2012), http://www.w3.org/TR/widgets/

[19] Griffiths, D., Johnson, M., Popat, K., Sharples, P., Wilson, S.: The educational affordances of widgets and application stores. Journal of Universal Computer Science 18(16), 2252–2273 (2012)

[20] Soylu, A., Mödritscher, F., Wild, F., De Causmaecker, P., Desmet, P.: Mashups by Orchestration and Widget-based Personal Environments: Key Challenges, Solution Strategies, and an Application. Program: Electronic Library and Information Systems 46(4), 383–428 (2012)

[21] Berners-Lee, T., Mendelsohn, N.: The Rule of Least Power. W3C (2006)

[22] Zuzak, I., Ivankovic, M., Budiselic, I.: Cross-context Web Browser Communication with Unified Communication Models and Context Types. In: MIPRO, 2011 Proceedings of the 34th International Convention, pp. 690–695 (2011)