Chapter 15

Interoperability: Standards for Learning Objects in Science Education

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ABSTRACT

This chapter offers a brief overview of the main ideas underlying the learning object (LO) paradigm, with special emphasis placed on pedagogical aspects. Requirements for the interoperability and reusability of learning objects (LOs) are discussed, with attention drawn to the need of developing new metadata models to fully benefit from this approach. The authors also claim a wider utilization of LO principle design based on educational research, to improve the chances of promoting efficient learning. A literature review on technology and science education is also provided, revealing a gap between computer and learning science, in relation to the embracement of the LO paradigm. Reflections on this situation and implications for the science education community are also included. Finally, one project on computer-supported science education is analyzed from the perspective of interoperability and reusability.

INTRODUCTION

Learning Objects and Science Education

Information and Communication Technologies (ICT) are an increasingly ubiquitous component of everyday life, also having a significant impact on education. Literature shows how the learning of relevant science topics may be enhanced by introducing computer assisted teaching materials, and provides convincing evidence for the application of ICT into education (Butler, 2006; Edelson, 2003; Edelson and Reiser, 2006; Krajcik and Blumenfeld, 2006; Linn, 2003a, 2003b; Linn et al., 2003; Spitulnik et al., 2003; White, 2003; Venkataraman, 2009). In addition, an easier access to information is provided and new, more versatile and flexible ways of communication are possible, augmenting the opportunities for social construction of knowledge. As a consequence, computer-based resources are being increasingly...
introduced into instructional processes and some authors are drawing attention to both, making a critical use of technology (Butler, 2007; Hoyles and Noss, 2009; Linn, 2003a) and developing new approaches to evaluate the real impact of digital materials and tools on learning (Beers et al., 2006).

However, an advanced literature search through Scopus (http://www.scopus.com/home.url), combining ‘learning object’ and ‘science education’ shows only a few results for the last nine years (1999-2009). This seems somewhat strange, when compared to the huge number of results displayed by the same search on just ‘learning object’ (over 1400 papers). These findings suggest that there is a gap between computer science and learning science in relation to the learning object approach, since most of the scientific works on LO are chiefly related to engineering and computer education.

On the contrary, research on technology-based science education reported a wide range of initiatives and projects, most of them, not explicitly embracing the LO paradigm (Butler, 2006, 2007; Edelson, 2003; Edelson and Reiser, 2006; Krajcik and Blumenfeld, 2006; Krange and Ludvigsen, 2009; Linn, 2003a, 2003b; Linn et al., 2003; Spitulnik et al., 2003; Su, 2008a, 2008b; White, 2003; Venkataraman, 2009).

Furthermore, many of the digital resources developed for science education are strictly designed for very specific teaching contexts or scenarios and therefore, the materials produced are not necessarily generic or exportable. Focussing on the development of versatile, shareable and reusable pedagogical materials will optimize creative efforts and allow the possibility of concentrating on improving resources, rather than duplicating efforts. Consequently, we argue that making the teaching science community aware of the potential benefits underlying the LO approach may enhance sharing and reusability of the technological resources developed for science learning.

The design of ICT-based resources may be carried out by those engaged in education, but this is not a guarantee that the materials produced will promote the desired effect. Frequently, these applications emerge from innovative teachers who act as designers and producers of their own pedagogical resources. Thus, the materials are created to suit their specific needs and classroom learning context. The development of effective electronic resources does not merely require intuition or the simple introduction of contents in specific formats using ready-made authoring tools. Teachers involved should look for answers on how to ensure efficient learning from ICT-based pedagogical materials, paying attention to any content types that may appear in e-learning approaches: facts, concepts, procedures, processes and strategic principles. Moreover, when approaching technological materials production, it would be convenient to take into account expert criteria based on available evidence. From this perspective, design-based research is focussed on connecting theory and educational research to orientate effective design of pedagogical resources (Design-based Research Collective, 2003). We develop this approach further in the next section.

In relation to design principles; one of the main concerns in the LO literature is the search of technical and pedagogical standards. These criteria are necessary to guide the production, search, delivery and sharing of reusable, high-quality contents and tools for e-learning experiences. Furthermore, a review of LO literature reveals a main interest in concepts such as granularity and interoperability, as key aspects to facilitate the reuse of digital resources and tools. We discuss these issues in the next section, paying special attention to pedagogical aspects.

The main purpose of this chapter is to offer an analysis of technology impact on science learning, providing a literature review, which points out that, the LO perspective is not a common approach in the science education community. Furthermore, we intend to discuss key aspects of the LO paradigm to promote reflection on the convenience of making people aware of the potential benefits.
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