Re-using Serious Games by encapsulating them in Learning Objects

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Introduction

The use of games within educational contexts has been gaining in popularity. There is evidence in the literature that the use of games in certain contexts can increase learning outcomes compared to traditional learning materials (Knight et al., 2010). These "serious" games have been used in different fields of study for training purposes, for example in cultural heritage (Anderson et al., 2009), healthcare (Mautone, Spiker, & Karp, 2008) disaster management (Haferkamp & Kraemer, 2010; Sanders & Rhodes, 2007), and general education (De Freitas & Conole, 2010). In most cases, these games have been developed as standalone activities for learners, with little integration into existing resources and environments. Consequently, the teacher must undertake to blend them into the learning environment and integrate them with their pedagogical approach. Learning Management Systems (LMS) are web-based e-learning systems for the delivery of educational content currently in use by many institutes and universities across the world. An increasing area of research focuses upon how the systems can support the delivery of a blended approach to learning and provide adaptive systems focusing on adaptivity and personalisation. Systems focusing more on delivering established pedagogies such as IMS-Learning design (IMS, 2003) have been developed and integrated into Learning Management Systems (LMSs) (Oneto, Abel, Herder, & Smits, 2009). Research into e-learning systems has also lead to a number of different standards such as ADL-SCORM (2004) for sharing courses among systems and IEEE LOM (2001) for sharing content in reusable packages, so called learning objects (Duval et al., 2001).

Despite their potential, most well-established e-learning systems and standards were not designed for integration with serious games. Consideration of how this integration could be achieved could allow improvement of the whole learning process, stimulating and motivating the learner through integrated game-based elements or content, whilst taking advantage of established techniques via traditional e-learning materials to provide a blended and holistic approach to the use of serious games. This integration could also increase the potential to reuse of serious games or parts of games, allowing content repurposing methods to be applied to Serious Games within modern LMSs. In this paper emerging trends in serious games repurposing are outlined, as we show how describing games as learning objects can significantly evolve the state of the art in game-based learning approaches (Dunwell et al., 2011; Torrente Vigil, 2009).

Repurposing

Research into repurposing learning objects has focused on automatic repurposing with learning objects such as PowerPoint presentations, creating new presentations from existing presentations ones (Jovanović, Gašević, Verbert, & Duval, 2005; Verbert & Duval, 2008; Zaka, Kulathuramaiyer, Balke, & Maurer, 2008) creating adaptive teaching materials from existing documents on mathematics at undergraduate level (Lenski & Wette-Roch, 2001) and text (Singh, 2004). Multimedia repurposing is another topic that has been researched and various systems (Steiger, Ebrahimi, & Sanjuan, 2003) such us MPEG-based personalized multimedia content delivery system have been built while other researchers have focused on developing repurposing frameworks. Hjelsvold, Vdaygiri, & Léauté (2001) for developed a framework for web-based interactive videos while Hossain, Rahman, & El Saddik (2004) introduced a multimedia content repurposing framework using Web Services.

Unlike multimedia, repurposing of serious games is still in its infancy, and there is only a small amount of research into the topic. Burgos, Tattersall, & Koper (2007) examined repurposing so called "generic" games, focusing on different pedagogic approaches in game repurposing, applied mainly to commercial games. Protopsaltis, Panzoli, Dunwell, & Freitas (2010) proposed a theoretical framework for repurposing serious games and described case studies based on the Climate Health Impact serious game. The case studies demonstrated the process of repurposing a serious game into new learning objects, covering three different aspects of content repurposing: language, content and pedagogy.

Different paradigms for content repurposing have been developed by the mEducator consortium (Dovrolis et al., 2009), which has shown that the need for programming skills is a limiting factor for widespread repurposing of game content. Hence, separating content is important in order to facilitate repurposing of a game. An editing tool called mEditor (Protopsaltis et al., 2011) was created to repurpose serious games within the mEducator project, allowing players and educators to create their own scenarios or alter existing ones to address their educational needs. mEditor is platform independent, achieved by declaring to the editor the features of the game engine and allowing the effective cross compatibility between game engines provided they both share similar features. XML files store references to game engine features as well as to branching generic features (such as "IfThenElse"). These files are read by the game engine that will "run" the scenario, calling at the right moment its own dedicated functions that were declared to the scenario editor (Protopsaltis et al., 2011).

Integration into e-learning environments

Designing pedagogical approaches that foster blended learning and combine elements of entertainment gaming with instruction methods remains a difficult task. However, Dunwell et al. (2011) have shown that serious games can be integrated into e-learning systems. This streamlines delivery and supports blended learning (Garrison & Vaughan, 2008). Whilst simple tasks can be easily transferred to a game and trained in a realistic way, complex tasks require a greater level of abstraction between game and reality. For example in stroke rehabilitation (Burke et al., 2009) and when training more complex behavioural aims defined at the top of Bloom's taxonomy (Bloom & Krathwohl, D. R., 1956), the blended approach is essential for learners to be able to make sense of the game experience (Egenfeldt-Nielsen, 2005; Vygotsky, 1978).

The integration developed by Dunwell et al. (2011) facilitates a structured experience while allowing exploration of non-linear environments. This uses a scaffolded learning approach built around successful behaviours. In order to achieve integration between game and LCMS, describing the serious games as a learning object is essential. Serious games have quite different characteristics from the more traditional e-learning materials and integration thus requires establishing a communication between the e-learning system and game, which for most other learning material is natively handled by the web-based platform. This can be achieved in various ways and Dunwell et al. have taken the approach of communicating with the LMs via advanced HTML and Javascript. The game is used as an alternative type of multiple-choice test, a feature that is present in most LMSs.

Metadata schema

Games are quite different forms of media to other educational media. Social or exploratory pedagogies are often couple to high fidelity audio and video in these serious games. As the use of technology to support the delivery and management of courses is becoming widespread, the use of reusable packages of content (learning objects) is increasing. However, doing the same with games is not an easy task and required developing a way to express games in coherent reusable terms, which make sense to educators rather than focussing on technical requirements. Like other types of

material, the context for which the game was intended is important information. The EduGameLab project has established a rating tool for serious games which records the context the game has been used in together with the ratings. Hendrix et al. (2012) defined a metadata schema for serious games which supports this rating tool. It extends on the usual fields of the IEEE LOM standard (IEEE, 2001). In addition to the technical and descriptive fields, to represent fully the game in a metadata form it is necessary to know some information about its usage context. Finally, the experiences of others who have used the game can also be a source of valuable information. Therefore, the metadata schema has fields for recording ratings or evaluations of the efficacy of a game within a given context. Games are often difficult to dismantle into components that are identifiable as independent learning objects: whilst they can contain multiple learning objectives, either the objectives are integrated or the technical architecture links them together making them difficult to decompose into discrete components. Therefore, whilst not traditionally part of a learning object, recording what type of learners particular games are successful with, and in what sort of context and with which topic of study is of particular significance and can serve as guidance to the teacher as to how best to use the game for his or her specific purposes.

Conclusions

The use of games in education is increasingly popular, as it is thought to have significant benefits over traditional methods (Knight et al., 2010) in many cases. Blended approaches to learning (Garrison & Vaughan, 2008), in which different technologies and traditional methods are combined, have become very popular. As a result, a significant volume of research has been conducted into using of e-learning, and standards have emerged. But these standards focus on traditional digital media rather than games. Bundling games into learning objects using similar methods and techniques as those applied to more traditional multimedia is problematic. This paper had reviewed recent advances in methods tackling this challenge. These include approaches to re-purposing, making it possible to modify games for a different purpose. This advances the state of the art by allowing educators to single out and re-purpose specific learning objectives with games. However, a game itself may still contain multiple learning objectives, and may still be difficult to deconstruct into independent components. An important area of future work is providing tools necessary to enable educators to undertake this repurposing in a simple and effective way.

Many institutions have adopted LMSs for the management and delivery of digital course material. These can also contain more advanced features such as tests. We have shown that games can be integrated into such LMSs not only as passive content, but also actively communicating about the students' progress, for example as alternative quizzes. This is a significant advance on the ability to create self contained and reusable learning objects containing games.

Finally, an important aspect of creating games as self contained learning objects is the ability to effectively describe them in terms of learning object metadata (LOM). To this end, we have introduced one of the first metadata schemas for serious games. The schema is an IEEE LOM based metadata schema, incorporating fields to describe the game not only in a technical sense, but also in terms of type of game play, of intended uses, and user ratings of the game in specific contexts. Evaluation and further standardization of metadata schemas is a key area of future work, leading to a general purpose metadata scheme. Games built on commercial closed-source APIs form a significant challenge; however games engines like Unity3D are starting to allow interaction with standards like ADL-SCORM (2004), which may lead to tighter integration with existing LMSs.

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