Using Formal Game Design Methods to Embed Learning Outcomes into Game Mechanics and Avoid Emergent Behaviour

Simon Grey, University of Hull, School of Engineering and Computer Science, Hull, United Kingdom
David Grey, York St. John University, York, United Kingdom
Neil Gordon, University of Hull, School of Engineering and Computer Science, Hull, United Kingdom
Jon Purdy, University of Hull, School of Engineering and Computer Science, Hull, United Kingdom

ABSTRACT
This paper offers an approach to designing game-based learning experiences inspired by the Mechanics-Dynamics-Aesthetics (MDA) model (Hunicke et al., 2004) and the elemental tetrad model (Schell, 2008) for game design. A case for game based learning as an active and social learning experience is presented including arguments from both teachers and game designers concerning the value of games as learning tools. The MDA model is introduced with a classic game- based example and a non-game based observation of human behaviour demonstrating a negative effect of extrinsic motivators (Pink, 2011) and the need to closely align or embed learning outcomes into game mechanics in order to deliver an effective learning experience. The MDA model will then be applied to create a game based learning experience with the goal of teaching some of the aspects of using source code control to groups of Computer Science students. First, clear aims in terms of learning outcomes for the game are set out. Following the learning outcomes, the iterative design process is explained with careful consideration and reflection on the impact of specific design decisions on the potential learning experience. The reasons those decisions have been made and where there may be conflict between mechanics contributing to learning and mechanics for reasons of gameplay are also discussed. The paper will conclude with an evaluation of results from a trial of computer science students and staff, and the perceived effectiveness of the game at delivering specific learning outcomes, and the approach for game design will be assessed.

KEYWORDS
Elemental Tetrad, Game Based Learning, Games Design, MDA Model, Source Control, Subversion

INTRODUCTION
In the field of games design, designers have long recognised the role of learning in games. Crawford (2011, p. 15) makes the assertion that “the fundamental motivation for all game playing is to learn” claiming that the purpose of games was to learn about the game domain, solve the problems and beat the challenges it presents by developing the required skills to do so. Koster (2010, p. 46) makes a bold claim that, “Fun is just another word for learning.” and that games are ultimately teachers.

In the field of education, the benefits of practical application and experiential learning have also been points of interest. Of particular interest is the idea of active learning, which Bonwell and Eison (1991, p. 2) summarise as involving “students in doing things and thinking about the things they are doing”. It is proposed that game-based learning fits neatly under the banner of active learning, but
also that the design of game based learning is critical to its success. Prince (2004) identifies three distinct types of active learning. They are collaborative learning, cooperative learning and problem-based learning.

Often the goal of game-based learning is engagement with learning material. For players, the games they play are often very engaging. Gros (2007, p. 23) points out that, whilst beneficial, engagement and motivation are “not enough for educational purposes” and alludes to games sometimes having undesirable emergent outcomes. However, the goal of winning a game represents an extrinsic motivator, one that is separate from the task in hand, as opposed to intrinsic motivation that comes from the task itself. Pink (2010) identifies several negative effects of extrinsic motivators, including an inability to see the bigger picture beyond an extrinsic motivator. This could be argued is imperative in game-based learning otherwise the risk is the student learns how to play and win the game without gaining an understanding of the learning outcomes themselves. Desirable learning outcomes must be well aligned with any extrinsic motivator in order to mitigate against any potential negative effects.

Habgood (2005) highlights the need for learning material to be intrinsically integrated into a game. In particular, games designed for learning should, “embody the learning material within the structure of the gaming world and the player’s interactions with it, providing an external representation of the learning content that is explored through the core mechanics of the gameplay” (p. 6). When playing a game for learning, students may well be engaged in the game, but that does not necessarily mean they are engaged in the learning. It is proposed that by integrating learning outcomes into game mechanics then the experience of playing the game and understanding the strategies available to achieve the game’s goal can become a more genuine learning experience.

Marne et al (2012) offer a framework of patterns to enable teachers to communicate more effectively with game designers. This framework begins with pedagogical objectives and domain simulation, again placing learning outcomes at the heart of the game mechanics. Identifying the desired learning outcomes from the outset is held in high regard.

**Game Design Methodology**

Schell (2008) describes the elemental tetrad as a conceptual tool for better understanding games design. Four elements of game design are linked to form a diamond. The elements are aesthetics, story, mechanics and technology. Arguably there are stronger links between aesthetics and story, and between mechanics and technology, but the general purpose of the conceptual tool is to consider if all four aspects are working together, in a consistent and synergistic way. The elemental tetrad of games design is shown in Figure 1.

Game design is a difficult process that requires a great many decisions making it a daunting and time consuming task. It may be tempting to create game based learning artefacts by “skinning” an existing game by adding the learning content as a theme, paying attention only to aesthetics. An example of this might be adapting an existing game by changing the story, for example. Given the complexity of designing a game from scratch it is easy to see how this might be an attractive option to educators who want to combine the engaging powers of a game with learning outcomes related to their teaching, however with this approach some elements of the tetrad are not intrinsically integrated because they will have been developed independently of the new story. Furthermore, because the mechanics may be entirely independent it may be possible to achieve the extrinsic goal of winning the game whilst also completely bypassing the story-based learning elements.

Schell (2008) describes games as designed experiences whilst also making the point that an experience is unique to an individual, and that even when two people share an experience they each have their own individual experience of the same thing. This is an important point when considering games as designed experiences, or educational games as designed learning experiences, as experiences are personal to an individual, and there may be a disconnect between the designer and the player. This is also a key tenant of the MDA model of games design, which is shown in Figure 2.
I Learn this Way!: Educational Workshop for Dyslexic Students
www.igi-global.com/chapter/learn-way-educational-workshop-dyslexic/72079?camid=4v1a

Smart People Learning: Self-Knowledge that Disrupts Practice in Meaningful Ways
Edith A. Rusch (2012). Disrupting Pedagogies in the Knowledge Society: Countering Conservative Norms with Creative Approaches (pp. 46-59).
www.igi-global.com/chapter/smart-people-learning/61779?camid=4v1a

A Constructivist Approach to Game-Based Language Learning: Student Perceptions in a Beginner-Level EFL Context
www.igi-global.com/article/constructivist-approach-game-based-language/196610?camid=4v1a