Chapter 68
A Randomised Controlled Trial to Evaluate Learning Effectiveness Using an Adaptive Serious Game to Teach SQL at Higher Education Level

Thomas Hainey
University of the West of Scotland, UK

Mario Soflano
University of the West of Scotland, UK

Thomas M. Connolly
University of the West of Scotland, UK

ABSTRACT

The literature suggests that every learner has a particular Learning Style (LS) and it is beneficial for the teacher and the learning approach to adapt to and accommodate these differences. The traditional classroom fails to motivate some learners and to maintain their engagement level during learning, possibly because of lack of interactivity. Computer games on the other hand seem to be able to engage participants for prolonged periods of time and motivate them to replay the game repeatedly. Some educationalists consider games as a potential platform to support learning and the term Games-Based Learning (GBL) has been introduced into the curriculum to reflect this approach. While many GBL applications have been developed, there is still a lack of empirical evidence to support its validity. Furthermore, there are very few adaptive GBL applications developed and adaptive GBL frameworks proposed. Another issue with GBL is that games engage the learners differently compared to traditional teaching approaches or eLearning and learning styles may differ inside and outside of the game. For the purpose of this research, a game with three game modes was developed. The modes were 1) non-adaptivity mode, 2) a mode that customises the game according to the learner's LS identified by a LS questionnaire, and 3) a mode with an in-game adaptive system based on a newly developed framework that can automatically adapt content

according to the learner's interactions with the game. GBL has been used to teach various disciplines; however, this research focuses on teaching Structured Query Language (SQL) at Higher Education (HE). A Randomised Controlled Trial (RCT) was conducted with 30 students for each of the above game modes and another 30 students in a control group who learned SQL using a traditional paper-based approach. The results show that the game developed, regardless of mode, produced better learning outcomes than those who learned from a textbook. Particularly for adaptive GBL, learning effectiveness was identified to be higher while the learning duration was shorter compared to the other modes of the game.

INTRODUCTION

It has been recognised by educationalists that each student has a different way of learning and processing information (Kolb, 1984; Felder & Brent, 2005). In the classroom, the benefits derived from delivering learning content in ways that match the learner's LS have also been identified (Smith & Renzulli, 1984; Price, 2004). As new modes of delivery of learning content such as computer-assisted learning systems (e.g. eLearning) have become increasingly popular, research into these has also identified the benefits of tailoring learning content to learning styles (Miller, 2005).

In terms of eLearning, Connolly and Stansfield (2006) have suggested, eLearning simply replicates the traditional education system (classroom style) and may be overly focussed on method of delivery, i.e. delivering materials over the web rather than on actual teaching and learning, and indeed motivating and engaging the learners in the learning process. In contrast, games, particularly video games, appear to be able to engage people over extensive periods of time and also motivate them to re-play the game repeatedly until they have mastered it (Kirriemuir & McFarlane, 2004). Therefore, some educationalists (for example, Prensky, 2006) have considered games to be a potential platform in supporting learning and have turned their attention to what is now called games-based learning (GBL).

While many GBL applications have been developed in the last two decades, there remains a lack of empirical evidence to support the use of GBL for learning purposes (Connolly *et al.*,

2012). Given that there appears to be genuine advantages for learning outcomes to be derived from the adaptation of teaching materials to learning styles in the classroom and remotely through eLearning, it may also be possible that GBL applications that are adapted to the individual's LS would improve learning outcomes. Kirriemuir and McFarlane (2004) have suggested that games, unlike classroom learning or eLearning, provide a different type of engagement as they demand constant interaction and generate a 'flow' that could assist in engaging learners. It is therefore possible for learners to adopt different leaning styles in GBL than they adopt in other learning settings.

In the next section, adaptivity is presented followed by a review of previous empirical work in adaptive GBL. Section 3 discusses the procedure for the Randomised Controlled Trial (RCT) including methodology, participants and marking scheme for SQL tests. Section 4 presents the results of the RCT with a particular emphasis on learning effectiveness in relation to learning styles, programme, gender, education level and completion time. Section 5 discusses the results and future research directions.

PREVIOUS RESEARCH

Definition of Adaptivity

In computing, there are two types of adaptation process: adaptability and adaptivity (Jameson, 2003). Adaptability refers to the ability of the

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