

Using Scratch with Primary School Children: An Evaluation of Games Constructed to Gauge Understanding of Programming Concepts

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ABSTRACT

Newer approaches such as games-based learning (GBL) and games based-construction are being adopted to motivate and engage students within the Curriculum for Excellence (CfE) in Scotland. GBL and games-based construction suffer from a dearth of empirical evidence supporting their validity as teaching and learning approaches. To address this issue this paper will present the findings of observational research at PE level using Scratch as a tool to construct computer games. A list of criteria will be compiled for reviewing the implementation of each participant to gauge programming proficiency. The study will review 29 games from Primary 4 to Primary 7 level and will present the overall results and results for each individual year. This study will contribute to the empirical evidence in games-based construction by providing the results of observational research across different levels of PE and will provide pedagogical guidelines for assessing programming ability using a games-based construction approach.

Keywords: Curriculum for Excellence, Evaluation, Games-Based Construction, Pedagogy, Primary Education, Programming, Review, Scratch

INTRODUCTION

Previously information and communications technology (ICT) was one area of the curriculum that Her Majesty's Inspectorate of Education reported should be improved upon within the primary school sector in Scotland to provide

children with increased opportunities to use computers (HMIE, 2009). Within the Curriculum for Excellence (CfE) teachers are being encouraged to make more use of different styles of approaches to learning, one of which is the use of ICT within learning. ICT as an approach to learning is being encouraged to develop children's digital literacy skills and some suggested means of implementing this are through the use

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of Glow – the Scottish schools intranet system or through games-based learning (GBL) (LTS, 2011a), which is supported by the Consolarium (LTS, 2011b), an initiative set up by Education Scotland to support teachers in exploring the use of GBL in their class. This is further enhanced within the curriculum that encourages children to make use of GBL through designing and creating their own games. Game construction is a relatively unexplored area especially within PE and a study by Vos, van der Meijden and Denessen (2011) has shown that children were more motivated to learn when constructing their own games over playing games.

This paper examines the use of game construction tools in the primary classroom to introduce children to programming. It will then present a coding scheme developed to evaluate Scratch games followed by an evaluation of games created through an introductory study on game construction with Scratch for three classes in the same primary school, with an in depth look at two of the games created and then discuss the results obtained. The paper concludes with a brief discussion on future research directions.

PREVIOUS WORK

Programming for Children

Programming can be taught from an early age (Gibson, 2003; Resnick *et al.*, 2009) and over the years there has been a number of languages developed aimed at the novice user (McNerney, 2004; Kelleher & Pausch, 2005). There have been many projects undertaken to introduce programming to children, though not all necessarily within the classroom. Some have created after school clubs to introduce children to computing (Borghini, De Ambrosio, & Masara, 1991; Gibson, 2003; Kelleher, Pausch, & Kiesler, 2007; Lindh & Holgersson, 2007; Malan & Leitner, 2007; Maloney *et al.*, 2008). Kelleher, Pausch and Kiesler (2007) created a programming environment that would engage girls more in programming by modifying the Alice platform. This was then tested using a

between-subjects study for both programming environments to identify which one they enjoyed using more. Results showed that the girls did prefer the modified programming environment; however this study only concentrated on girls. The Toontalk programming environment has a video game-like style with animations within it symbolising programming attributes; e.g. a house in Toontalk represents an object or actor in programming (Kahn, 1996) and has been used in a study with pre-school children (Morgado & Kahn, 2008).

Adventure author is another example of a programming tool designed to make games and is aimed at children aged 10-14 (Robertson & Good, 2005). The tool allows children to create their own interactive story, which other children are then able to play. This is also similar to Storytelling Alice, (Kelleher, Pausch, & Kiesler, 2007), which was used as an approach to encourage girls to develop an interest in computer programming and is based on Alice (a freeware object-oriented educational programming language). The use of electronic toys is another way in which children can be taught about programming, programmable bricks (Wyeth & Purchase, 2000) and Lego toys such as *Mindstorms*. Using *Lego Mindstorms* children were taught some basic computer concepts over six months, with lessons structured so that they started off as being teacher-led then eventually allowed pupils to work on their own (Barrios-Aranibar *et al.*, 2006).

Games-Based Construction

Van Eck (2006) suggests from a review of the literature that there are three ways of introducing GBL into educational establishments either through the students creating their own games, use of serious games or through the use of commercial off the shelf (COTS) games. This is in line with Seymour Papert's vision that children should be programming the computer rather than being programmed by the computer through computer-aided learning (Papert, 1980). Kahn (2007) and Kelleher and Pausch (2005) have shown that since Logo was created in 1967 many

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