Computers & Education 71 (2014) 237–246

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Children's engagement during digital game-based learning of reading: The effects of time, rewards, and challenge

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A R T I C L E I N F O

Article history:
Received 28 June 2013
Received in revised form
18 October 2013
Accepted 19 October 2013

Keywords:
Elementary education
Evaluation methodologies
Evaluation of CAL systems
Interactive learning environments

A B S T R A C T

This study investigated the effects of two game features (the level of challenge and the reward system) on first and second graders' engagement during digital game-based learning of reading. We were particularly interested in determining how well these features managed to maintain children's engagement over the 8-week training period. The children ($N = 138$) used GraphoGame, a web-based game training letter–sound connections, at home under the supervision of parents. Data regarding the children's gaming and engagement were stored on the GraphoGame online server. A 2 × 2 factorial design was used to investigate the effects of the level of challenge (high challenge vs. high success) and the presence of the reward system (present vs. absent). Children's engagement was measured by session frequency and duration and through an in-game self-report survey that was presented at the end of the each session. According to the results, the children enjoyed GraphoGame but used it less frequently than expected. The reward system seemed to encourage the children to play longer sessions at the beginning of the training period, but this effect vanished after a few sessions. The level of challenge had no significant effect on children's engagement. The results suggest a need to investigate further the effectiveness of various game features in maintaining learner's engagement until the goals set for learning are achieved.

1. Introduction

Playing computer games is a popular leisure-time activity among young children. In Finland, 84 percent of first graders play computer games at least sometimes, 31 percent every day (Hirvonen, 2012). Computer games can hold children's attention for hours a day, so it is not surprising that many parents and teachers are interested in their potential as educational and motivational tools. Several studies suggest that children enjoy computer-based learning tasks more than traditional learning tasks (Barrera, Rule, & Diemart, 2001; Rosas et al., 2003; Seymour, Sullivan, Story, & Mosley, 1987; Tüzün, Yılmaz-Soylu, Karakuş, İnal, & Kızılkaya, 2009; Wrzesien & Raya, 2010). Also, children seem to concentrate better while engaged in computer-based learning than in traditional school tasks (Clarfield & Stoner, 2005; MacArthur, Haynes, & Malouf, 1986; Mautone, DuPaul, & Jitendra, 2005; Ota & DuPaul, 2002).

Despite the apparent motivational appeal of digital learning, little experimental research concerning the long-term development of engagement during digital game-based learning has been conducted. When computer-based learning activities or games are introduced to young learners, they typically trigger curiosity and interest (Mitchell, 1993; Seymour et al., 1987). However, this type of interest is situational, triggered by environmental stimuli and it may or may not last over time (Hidi & Renninger, 2006). Some earlier studies imply that interest triggered by educational software may be short-lived (Goodwin, Goodwin, Nansel, & Helm, 1986; Kerawalla & Crook, 2005), but also relatively long-lasting interest has been observed (Rosas et al., 2003). If the situational interest triggered by a novel learning tool can be maintained for a longer period of time, it may eventually develop into what Hidi and Renninger (2006) called individual interest, a relatively enduring predisposition to seek repeated reengagement with particular content over time. Interest often has a positive impact on learning. For example, interest in recreational reading has been found to predict the development of reading ability during the first years of school

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0360-1315/$ – see front matter
http://dx.doi.org/10.1016/j.compedu.2013.10.008

(Kirby, Ball, Geier, Parrila, & Wade-Woolley, 2011). In contrast, children who spend little time engaged in reading activities may develop a reading disability at school age, even when they have no cognitive risk factors in their background (Eklund, Torppa, & Lyytinen, 2013).

1.1. Engaging the learner

Intrinsic motivation refers to a situation where actions are performed in the absence of any apparent external contingency, that is, an intrinsically motivated person finds the activity rewarding in itself and does not expect to gain anything particular, such as extrinsic rewards, from it (Deci & Ryan, 1980). The concept of flow is related to intrinsic motivation because, when in the state of flow, a person's activity is autotelic, rewarding in itself, and extrinsic outcomes of the activity have little personal significance (Nakamura & Csikszentmihalyi, 2002). The concept of flow emphasizes the subjective experience of this state, which is characterized by intense and focused concentration, the merging of action and self-awareness, a sense of control, a loss of reflective self-consciousness, and a distortion of temporal experience (Nakamura & Csikszentmihalyi, 2002).

According to the theory by Malone (1980), computer games that provide challenge, that include elements of fantasy, and that rouse the curiosity of the learners are intrinsically motivating. Lepper and Malone (1987) also include control, suggesting that young learners should have opportunities for making choices about instructionally irrelevant aspects of the activity, such as types and names of characters and fantasy elements. Providing choice within a digital game potentially enhances the player's perception of autonomy, which in turn has been shown to increase intrinsic motivation (Ryan, Rigby, & Przybylski, 2006). The results of experimental studies support these design principles. For example, Parker and Lepper (1992) found that embedding computer-based instruction in a fantasy context had positive effects both on children's learning and interest in the learning task. In another study, Cordova and Lepper (1996) found that in addition to fantasy embellishments, the provision of task-irrelevant choices, such as a choice of type of spaceship in a computer game, improved children's intrinsic motivation and learning of the subject matter. More recently, Sweetser and Wyeth (2005) have developed a series of criteria for designing engaging computer games on the basis of the flow theory. According to their GameFlow model, the elements that produce flow in computer games include concentration, challenge, control, clear goals, feedback, immersion, and social interaction. This model has been used in the evaluation of computer games for different user groups. For example, Inal and Cagiltay (2007) examined the flow experiences of 7- to 9-year-old children in a social game environment and found that the majority of the children emphasized challenge as the most important flow element. Games that included challenge levels and clear, immediate feedback seemed to produce flow experiences most frequently. Ke and Abras (2013) found that students with special learning needs seemed to enjoy games that comprise simple fantasy with instant rewards, and the students also benefited from visual cuing, or feedback. Ke and Abras (2013) also emphasize that it is important that the academic content is integrated in the game-play, not just added to the fantasy context, and that game challenges match the diverse skill levels of the students.

1.2. GraphoGame

GraphoGame (in Finnish "Ekapeli") is a web-based learning game developed at the University of Jyväskylä in Finland. Its development originated from the findings of the Jyväskylä Longitudinal Study of Dyslexia (see e.g. Lyytinen et al., 2006). In this extensive study, the language and reading development of 200 children, half of whom have a familial risk for dyslexia, has been followed from birth to the age of 15 so far. The findings suggest that difficulties in perceptual differentiation of acoustically close phonemes and, at least partly consequential to that, difficulties in the learning of the connections between letters and sounds are predictors of future reading problems (e.g. Lyytinen, Erskine, Kujala, Ojanen, & Richardson, 2009). GraphoGame was developed to help children overcome these difficulties.

In GraphoGame, the player hears a single phoneme or a longer phonemic unit while a number of graphemes (target and distracters) appear on the screen (Fig. 1). The player's task is to find the grapheme matching the spoken phoneme and to click it with the mouse. This is followed by immediate feedback that informs the player whether the choice was correct or incorrect. After an incorrect answer, the correct alternative is highlighted before the next trial is presented. When the child has learned the connections between sounds and letters, the

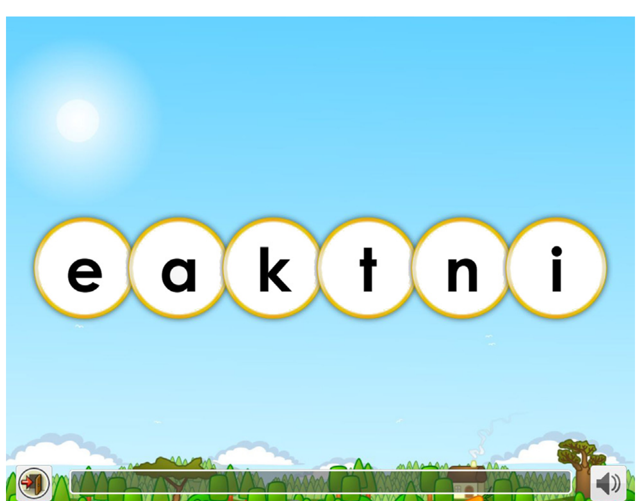

Fig. 1. An example of a GraphoGame training task in which the player hears a letter sound and is expected to find the matching letter from the alternatives shown on the screen.