

Measuring the noticing of an unexpected event in Magical Garden with a Teachable Agent using Eye-Tracking

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Not developing number sense in childhood can have dire consequences: failing early mathematics and developing learning disabilities later on (Griffin, Case, & Siegler, 1994; Gersten, 1999; Chard et al, 2005). How do you catch children's attention and promote learning? The importance of play as a pedagogical tool for teaching and to get children motivated in their acquisition for new abilities has been known for many years (Griffin, Case, & Siegler, 1994; Geary, 1995; Gee, 2003). With new technology, a genre of educational games for mathematics has emerged. Utilizing the motivational and captivating power of computer games, educational games for mathematics have shown an effect on both learning and motivation (Schwartz, 2004; Moreno, 2005). The educational game Magical Garden has all the prerequisites for training and testing number sense, and the help of a *Teachable Agent* (TA). Axelsson et al. (2013) requested further research on preschooler's social interaction with TA. Schneider et al. (2008) emphasized the validity and utility of using eye-tracking as a measure of developing number sense. The close connection between top-down control and eye movements (Henderson, 2003; Deubel & Schneider, 1996), as well as Smith (2012) provide grounds for considering that noticing something unexpected could be manifested as visual attention towards an *Area of interest* (AOI).

In the present study, eye-tracking was used as method to record if children noticed an unexpected event in Magical Garden. The unexpected event was designed in a way that only the children who had a sufficient level of number sense would react and notice the unexpected event. The unexpected event was a tree elevator malfunction; the elevator passed the correct level and crashed in the tree top. A model of detection was proposed: Looking back at the AOI of the correct level. The corresponding hypothesis was: "Looking back" would correlate with the performance in Magical Garden. Performance was the rate of correct answer in the eye-tracking session. Other eye-movements such as anticipation, and looking at the elevator button were collected.

In this study, 40 preschoolers participated (21 girls, $M=4.6$, $SD=0.72$), from three preschools, in the south of Sweden. The study consisted of two phases; first a training phase, and then an eye-tracking experiment. The eye-tracking experiment was conducted at the preschools, by having children play the specially designed version of Magical Garden. The child and the TA took turns being in charge in the game. Will the children look at the TA during an unexpected event and is there a difference in "look at TA" depending on who was in charge?

A significant result was found in that "looking back" correlated to performance, $p = 0.018$, 95% CI of [0.067 – 0.679]. A significant difference was found in that children looked at a higher rate at the TA when the TA was in charge, $p < .001$, 95% CI of [0.064-0.223]. With an explorative look at the eye-movement data, "looking at the elevator button" correlated strongly with performance $r(38) = .50$, $p < .001$.

This study introduces the noticing of an unexpected event as novel way of getting children to expose their level of number sense without being in a test situation. The proposed model of noticing, a look back, did not account for the whole notion of detecting an unexpected event. However, a better model of noticing could be constructed by combining measurements of verbal, non-verbal detections, as well as eye movements such as "look back" and "look at button". Future research could learn from this study and examine the possibility of creating a better model of noticing.

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