TRAINING ADAPTIVE EXPERTISE WITH ARITHMETIC PROBLEM SOLVING IN A GAME-BASED CONTEXT

Boglárka Brezovszky, Jake McMullen, Gabriela Rodriguez, Erno Lehtinen
Centre for Learning Research, Department of Teacher Education, University of Turku

Keywords: adaptive expertise; arithmetic problem solving; educational digital game

When targeting the development of adaptive expertise with arithmetic, more emphasis should be placed on providing students with contexts for discovering underlining relationships between numbers and operations (*Baroody*, 2003; *Threlfall*, 2009). Digital games by their nature represent an engaging context for exploration and discovery learning and can provide a promising medium for extended practice with number combinations (*Devlin*, 2011). The aims of this pilot study were: (1) to test possible measures of adaptive arithmetic strategies; (2) to explore the relationship between these measures and indicators of adaptive problem solving skills within the context of the NumberNavigation Game (NNG).

Participants were 6th grade students (N=22; avg. age 12; 11 girls) from one classroom. Parallel versions of the adaptive arithmetic skill test were administered during pre- and post-test. Students played the NNG in pairs, once a week, for 7 weeks. The test of adaptive arithmetic skills consisted of 4 items; for each item, students had 1.5 minutes to complete it. Students were asked to reach the same solution by combining a given set of numbers and operations in as many ways as possible. Items were scored on four criteria: correct answers, number of numbers and operations used, and number of answers given with multi-operation combinations. NNG is a digital game where players navigate a ship through the hundred-square placed over various archipelago landscapes. Navigation means the strategic selection of number-operation combinations while continuously adapting playing strategies according to the changing game modes and map structures. After completing a map players receive bronze, silver or gold medals according to their performance (*Brezovszky* et al., 2013). In this study, the quality of gaming was measured in terms of the total number of gold medals collected upon the first completion of the first four maps (Level I).

Paired-sample t-test showed significant pre- to post-test development in the number of correct responses ($t(21)=-2.62$, $p=.02$) and number of operations used ($t(21)=-3.22$, $p<.001$); and a close to significant increase in the number of multi-operation solutions used ($t(21)=-2.01$, $p=.06$). Repeated measure ANOVA comparing low vs. high gaming quality groups (based on the amount of gold medals received) showed a moderate interaction effect of gaming quality and time point for multi-operation solutions ($F(1, 19)=3.089$, $p=.095$, $\eta p2 =.14$), indicating that students with a better gaming quality improved more than their peers in their use of multi-operation solutions from pre- to post-test.

Results suggest that the described indicators may represent a reliable way of measuring adaptive arithmetic problem solving strategies although more evidence is needed to further validate these claims. Additionally, those with a stronger disposition of experimenting with alternative number combinations might have a better chance to develop as a result of the gameplay.