Game experience and the effectiveness of Number Navigation Game

Gabriela Rodríguez Padilla\(^a\), Boglarka Brezovszky\(^a\), Nonmanut Pongsakdi\(^a\), Tomi Jaakkola\(^a\), Minna Hannula-Sormunen\(bc\), Jake McMullen\(^ab\), Erno Lehtinen\(^ab\)

\(^a\)Centre for Learning Research, University of Turku, Finland
\(^b\)Department of Teacher Education, University of Turku, Finland
\(^c\)Turku Institute for Advanced Studies

**BACKGROUND**

The Number Navigation Game (NNG) has been developed to enhance students’ arithmetic flexibility and adaptivity. Players control a ship by inputting mathematical equations which take the ship from one numerical-location to another. The NNG was conceived as an engaging platform in which to explore and reflect upon number combinations and the relationships between numbers.

The aim of the study is to find out whether the NNG is effective at increasing students’ arithmetic fluency and achievement motivation and to investigate the role of game experiences on these. Motivation is looked at through the expectancy-value model (Wigfield & Cambria, 2010) and is comprised of self-efficacy, interest, attainment value, utility, and cost, while the dimensions of game experience are flow, immersion, competence, challenge, positive affect, negative affect, tension, and positive value.

**METHOD**

- Participants: Sixty-one 4th-6th grade classes (N=1168 students) were randomized into experimental (n=642) and control (n=526) groups.
- Design: Pre-test \(\rightarrow\) intervention 10-week period \(\rightarrow\) post-test. Control group continued with traditional book-based curriculum.
- Measures: Pre- and post- tests on arithmetic fluency and expectancy-values, post-test Game Experience Questionnaire (Poels and colleagues, 2010). A K-means cluster analysis was carried out based on self-reported game experiences and students were sorted into three groups (negative game experiences, positive game experiences, mixed game experiences).

**RESULTS**

**Effects of Intervention on Arithmetic Fluency**

Repeated Measures by condition: Interaction effect of arithmetic fluency and condition (phase/experimental):

\[ F (1,986) = 5.994, p = 0.015, \eta^2 = 0.006 \]

K-means cluster analysis by game experience:
- Positive game experiences (n=83)
- Mixed game experiences (n=206)
- Negative game experiences (n=151)

Repeated Measures by game experience: No interaction effect on arithmetic fluency but effect on expectancy-values.

**CONCLUSIONS**

- The intervention had a positive effect on arithmetic fluency.
- The game experiences moderated the effectiveness of intervention on expectancy values but not on arithmetic fluency. The expectancy-values of students with mixed or negative game experiences decreased, while these values increased for students with positive game experiences.
- Based on the results the next steps are to study the game’s efficacy in promoting adaptivity in arithmetic problem solving and to further develop the game to see whether new game features lead to meaningful improvements in game experiences.

**REFERENCES**


Contact info: gabrod@utu.fi