Effects of playing mini-games on multiplicative abilities
A first exploration

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Introduction
Developing knowledge and understanding of multiplicative relations is a main goal of primary school mathematics education. It is important that students consolidate basic multiplication table facts as well as learn how to flexibly apply this knowledge in more complex multiplicative problems (e.g., 1, 2). Mathematical computer games are considered to contribute to attaining both these learning goals (e.g., 3). However, as recent review articles have pointed out, clear empirical evidence of the effects of educational computer games is sparse, and in-class longitudinal studies are needed (e.g., 4, 5). In the BRXXX study we use a large-scale longitudinal design to provide evidence for the domain of multiplication and division. Moreover, our study goes beyond the use of computer games in class and also includes playing games at home. We investigate the effects of multiplication and division mini-games from the popular website RekenWeb (www.rekenweb.nl).

Research questions
1. What are the effects of playing multiplicative mini-games on students’ multiplicative abilities?
2. In what setting are multiplicative mini-games most effective?
In this poster, we address the preliminary results from the first year of the study.

Research design
The research questions are answered by a repeated measures control-group design containing four conditions:
- **E1** Playing multiplicative games at school, embedded in a lesson
- **E2** Spontaneously playing multiplicative games at home, minimal attention at school
- **E3** Spontaneously playing multiplicative games at home, discussion at school
- **C** Control group: Playing games on other mathematics topics at school

Games
In each intervention the students were offered eight online games. Experimental groups: games on practice and understanding of multiplicative relations. Control group: alternative games, mostly on spatial orientation. Students had a unique login name. Game-play data were collected through DME software.

Catching (© Freudenthal Institute)

![Game Image]

Start How many ladybugs?...

Score: 0

Choose an amount (© Freudenthal Institute)

Start Which box do you choose?...

Score: 0

Participants
In the BRXXX study, 58 classes of 54 regular primary schools are participating, with a total of 1197 students. The schools have been randomly assigned to one of the four conditions.

BRXXX Multiplicative Ability Test
- Online test, administered at school
- Different tests in different grades, linked through anchor items
- Multiplicative items and distractor items
- Context items, bare number items, flexible application items
- Four different versions of each test to control for order effects
- Test 1: 28 multiplicative items
- Test 2: 50 multiplicative items (of which 16 were also included in Test 1)

Data Analysis
In our preliminary analysis of the effects of Interventions 1 and 2 (Grade 2), we included only the students who made both Test 1 and Test 2 (n = 885). Student’s scale scores (median Likelihood estimators) were computed using the same performance difficulties of anchor items. Linear regression models were employed with gain scores (Test 2 – Test 1) as the dependent variable. Because of the clustered data (students nested within schools) cluster robust standard errors were utilized (6).

Results

<table>
<thead>
<tr>
<th>Condition</th>
<th>n</th>
<th>Gain Score*</th>
<th>Comparison of E to C</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>314</td>
<td>2.30 ± 1.70</td>
<td>E: 1.30 ± 0.15, 0.15 *</td>
</tr>
<tr>
<td>E1</td>
<td>571</td>
<td>2.45 ± 1.81</td>
<td>0.15 *</td>
</tr>
<tr>
<td>E2</td>
<td>181</td>
<td>2.36 ± 1.74</td>
<td>0.12 *</td>
</tr>
<tr>
<td>E3</td>
<td>234</td>
<td>2.34 ± 1.73</td>
<td>0.11 *</td>
</tr>
<tr>
<td>E1</td>
<td>156</td>
<td>2.71 ± 2.00</td>
<td>0.21 *</td>
</tr>
</tbody>
</table>

Total 885 2.40 ± 1.71

Regression analysis of the effects of Interventions 1 and 2 (Grade 2), n = 885. Student’s t-test (*p < 0.05) was used as a comparison to the control group.

Discussion
The preliminary results of this study show that using mini-games for developing knowledge and understanding of multiplicative relations (E) is not necessarily more effective than regular instruction without multiplicative mini-games (C). The way in which the mini-games are deployed in education turned out to be crucial. Playing multiplicative mini-games was only effective when they were played at home and discussed in school afterwards (E3). However, the effective ingredient of the E3 intervention is not just the playing at home, as may be explained by the possibility that the in-class discussion promotes deeper understanding of the concepts encountered in the games. Furthermore, when comparing E3 with E1, the in-class discussion in E3 can be considered to be more fruitful than the lesson in E1 because of the richer experience gained from the free home playing. Moreover, in the E3 condition, the children may have spontaneously spent more time on practicing multiplicative problems. Further analyses will be carried out to get a better understanding of the effects of playing multiplicative mini-games.

References

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