Attitude towards mathematics:

Its development in the early primary school years, and its relation with mathematics achievement, gender, and playing mathematics computer games

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Attitude towards mathematics

An important factor in mathematics education

- Can facilitate mathematics learning and thereby enhance mathematics achievement  
  e.g., Aunola et al., 2006; Viljaranta et al., 2009

- Predictor of later mathematics course selection  
  e.g., Gottfried et al., 2013; Nagy et al., 2006; Watt, 2006

- Predictor of general educational level attained  
  e.g., Gottfried et al., 2013
Attitude towards mathematics

- Decreases over the grades
  e.g., Fredricks & Eccles, 2002; Gottfried et al., 2001

- Is often higher for boys than for girls
  e.g., Meelissen & Luyten, 2008, Nurmi & Aunola, 2005
  or there is no difference
  e.g., Lerkkanen et al., 2012; Meelissen et al., 2012

- May have a cyclic relationship with mathematics achievement
  e.g., Aunola et al., 2006; McLeod, 1992

- May be promoted through positive experiences, such as playing mathematics computer games
  e.g., Ke, 2008; Ke & Grabowski, 2007
Attitude towards mathematics: What is it?

Often used as umbrella term
- Liking/enjoyment
- Competence beliefs
- Beliefs of importance
- Mathematics anxiety
- ...

e.g., Fennema & Sherman, 1976; McLeod, 1994; Neale, 1969
Attitude towards mathematics: What is it?

Often used as umbrella term

Liking/enjoyment \textit{cf. McLeod, 1992}

- Competence beliefs
- Beliefs of importance
- Mathematics anxiety
- ...
Attitude towards mathematics: What is it?

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**Intrinsic or interest value**
Eccles, 1983

**Intrinsic motivation**
e.g., Ryan & Deci, 2000

**Task motivation**
e.g., Aunola et al., 2006; Viljaranta et al., 2009

**Interest**
e.g., Frenzel et al., 2010;
Lerkkanen et al., 2012
Research questions

1. How does students’ attitude towards mathematics develop in the early grades of primary school?
2. How is this development related to the development of other school-related attitudes?
3. How is this development related to students’ gender?
4. How is students’ attitude towards mathematics related to their achievement in mathematics?
5. Does the extent of playing mathematics computer games influence students’ attitude towards mathematics?
Context of the study

BRXXX-project: Longitudinal study into the effects of computer games on the development of multiplicative reasoning

<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mrt</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 2</td>
<td>Game period 1</td>
<td>T2</td>
<td>Game period 2</td>
<td>T3</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Grade 3</td>
<td>Game period 3</td>
<td>T4</td>
<td>Game period 4</td>
<td>T5</td>
<td></td>
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<tr>
<td>Grade 4</td>
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<td>T6</td>
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</tr>
</tbody>
</table>
Participants

- 45 Dutch primary schools
- 932 students

Analyses on gameplay:
- 29 primary schools
- 606 students
Attitude questionnaire

- Administered online
- 40 items: mathematics, other school subjects, out-of-school activities
Attitude scales

- Attitude towards mathematics
  18 items, Cronbach’s alpha .85-.88

- Attitude towards reading
  3 items, Cronbach’s alpha .64-.73

- Attitude towards school
  2 items, Cronbach’s alpha .73-.81
Mathematics achievement tests

- Cito LOVS mathematics tests
- Reliability .91-.97
Mathematics games

- 4 game periods of 10 weeks
- 8 mini-games per period (multiplication and division)
- Three conditions:
  - E1 playing at school
  - E2 playing at home
  - E3 playing at home with debriefing at school
- Gameplay behavior measured through logdata:
  - time spent on games
  - number of exercises attempted
  - number of correct attempts
  - number of games played
Development of mathematics attitude

Results

Moderately positive attitude in Grade 1
Development of mathematics attitude

**Results**

Significant negative slope

\[ B = -0.074, \ SE = 0.006, \ p < .001 \]

Average decrease of 0.10 SD per half year
Mathematics attitude vs. other attitudes

Results

Math attitude < Reading attitude \( d = -0.18 \)
Math attitude > School attitude \( d = 0.09 \)

All have sign. negative slope
Reading: \( B = -0.028 \)
School: \( B = -0.039 \)
Mathematics: \( B = -0.074 \)
Mathematics attitude and gender

Attitude girls > attitude boys \((d = 0.17)\)
No difference in slopes
Mathematics attitude and mathematics achievement

Concurrent correlations

<table>
<thead>
<tr>
<th>Time point</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>.158***</td>
<td>.123**</td>
<td>.130***</td>
<td>.074*</td>
<td>.062*</td>
<td>.018</td>
</tr>
</tbody>
</table>

* p < .05. ** p < .01. *** p < .001. One-tailed.
Results

Mathematics attitude and mathematics achievement

Cross-lagged path model

* $p < .05$. ** $p < .01$. *** $p < .001$. One-tailed.
Mathematics attitude and playing mathematics computer games
Mathematics attitude and playing mathematics computer games

<table>
<thead>
<tr>
<th>Path</th>
<th>E1 (n = 168)</th>
<th>E2 (n = 253)</th>
<th>E3 (n = 185)</th>
<th>Averaged over conditions (n = 606)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per game period</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gplay1 → MAtt T2</td>
<td>.100*</td>
<td>.048</td>
<td>.024</td>
<td>.061†</td>
</tr>
<tr>
<td>Gplay2 → MAtt T3</td>
<td>-.057</td>
<td>.084</td>
<td>.041</td>
<td>.034</td>
</tr>
<tr>
<td>Gplay3 → MAtt T4</td>
<td>.128**</td>
<td>-.047</td>
<td>.032</td>
<td>.022</td>
</tr>
<tr>
<td>Gplay4 → MAtt T5</td>
<td>.000</td>
<td>.017</td>
<td>.078†</td>
<td>.048</td>
</tr>
<tr>
<td>Averaged over game periods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gplay → MAtt</td>
<td>.039†</td>
<td>.024</td>
<td>.049*</td>
<td>.044*</td>
</tr>
</tbody>
</table>

\[ p < .20. * p < .05. ** p < .01. One-tailed. \]
Conclusions (1)

- Early primary school children have a moderately positive attitude towards mathematics
cf. Dowker et al., 2012; Meelissen et al., 2012

- Mathematics attitude declines over the grades
cf. Fredricks & Eccles, 2002; Krinzinger et al., 2009

- The decline in mathematics attitude is steeper than in attitude towards reading or school
cf. Gottfried et al., 2001

- Girls have a higher attitude towards mathematics than boys have
contrary to earlier findings, e.g., Meelissen et al., 2008; Nurmi & Aunola, 2005
Conclusions (2)

- Mathematics attitude and mathematics achievement are related, mathematics achievement may predict later mathematics attitude.
  
  \textit{cf. Gottfried et al., 2007; Krinzinger et al., 2009; Ma & Kishor, 1997}

- Playing mathematics games may contribute to promoting mathematics attitude, but more research is needed here.
  
  \textit{cf. Ke, 2008; Ke & Grabowski, 2007}
Thank you!

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