Future Schools in 2030
The Developmental Dynamics of Cognition, Mathematics, Motivation and Well-being
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The aim of this research project
The Developmental Dynamics in Cognition, Mathematics, Motivation and Well-being
Individual differences

Situational factors

Emotions

Situational motivation

Motivated activity

Self-focused activity

Task-focused activity
Individual differences

Situational factors

Emotions

Situational motivation

Motivated activity

Self-focused activity

Task-focused activity

Self-focused activity

Task-focused activity

Motivated activity

Situational motivation

Emotions

Situational factors

Individual differences
Individual differences

Situational factors

Situational appraisals

Emotions

Situational motivation

Motivated activity

Self-focused activity

Task-focused activity

Development

Educational setting

Cultural context
Goal of the project

To examine the developmental dynamics in cognition, mathematical skills, motivational tendencies, and well-being within two different educational settings.
Points of interest

1. Longitudinal design
2. Cross-cultural comparison
3. Broad view on learning and achievement
Previous research

- Skill development in mathematics
- Development of motivation
- Developmental interplay between math learning and motivation
Early predictors of math-related motivation
Nuutila, Tuominen-Soini, Niemivirta (in prep.). Developmental predictors of interest, success expectancy and task performance in mathematics.
Early predictors of math-related motivation

Nuutila, Tuominen-Soini, Niemivirta (in prep.). Developmental predictors of interest, success expectancy and task performance in mathematics.

- Success expectancy and performance predicted by visuo-spatial working memory and reasoning ability
- Task interest independent of prior core abilities
- Change in later success expectancy predicted by task performance, but not the other way around
Long-term predictions of math-related motivation


\[ \chi^2 (206) = 554.49, p < .001 \]

CFI = .96, RMSEA = .04, SRMR = .04
• Task interest independent of prior core abilities

• Change in later success expectancy predicted by task performance, but not the other way around

• Math-related intrinsic value predicted mostly by previous task interest, math self-concept mostly predicted by previous success expectancy

• Achievement predicted by previous task performance
Motivational and cognitive predictors of math performance
After controlling for differences in reasoning ability,

- goals influenced math performance indirectly via control expectancy,
- control expectancy influenced math performance directly and indirectly via working memory,
- visuo-spatial working memory predicted more working-memory intensive math performance
Development of math-related interest, self-concept and achievement

Tapola & Niemivirta (in prep). Developmental trajectories of school beginner’s perceived competence, interest and performance in mathematics.
Development of math-related interest, self-concept and achievement

Tapola & Niemivirta (in prep). Developmental trajectories of school beginner’s perceived competence, interest and performance in mathematics.

- Significant decrease in interest and perceived competence over time (from 1<sup>st</sup> to 3<sup>rd</sup> grade)
- Decrease in competence perceptions was less steep for boys
- Later math performance independent of math interest
- Later math performance predicted by the level of perceived competence
- Later math performance predicted by less steep decrease in competence perceptions
A model of the development of basic mathematical skills
A model of the development of basic mathematical skills


- Based on existing mathematical skills assessment batteries and longitudinal studies review analysis we have formed a model of core numerical skills in age group 5-8 years of children
- There is no core factor model for basic mathematical skills development in age group 9-12 years –it is needed for detecting children at risk for problems in mathematics learning
Longitudinal studies into mathematical development
Longitudinal studies into mathematical development

- Early numeracy: relational skills (ability to organize and compare quantities) and counting skills (ability to operate with number-word sequence)
- Individual differences in early numeracy skills can be detected before school age
- Differences in the beginning of the kindergarten were visible also in the end of the kindergarten
Longitudinal studies into mathematical development

Longitudinal studies into mathematical development


- Early numeracy skills (relational and counting skills) are good predictors for first grade arithmetic skills (basic and applied) and general math performance.
- Inattention in kindergarten test situation predict the teacher’s way to evaluate child’s math performance in first grade.
- Early skills + task focused behaviour explains later learning.
Cross-cultural studies into mathematical development
With respect to counting skills, the Chinese children outperformed the Finnish children irrespective of age, whereas in relation to relational skills, this was true only among the older children.

Cross-cultural differences exists already before comprehensive school and there is changes in age groups.
Mathematical development and other learning related factors


**Fig. 2.** Students' latent mean scores on performance and well-being scales as a function of group membership.
• Low performance was related to negative academic well-being (feeling of learning difficulties and burn-out) in 9th graders

• Student profiles with negative academic well-being (NAWB+low performance, NAWB+average performance) had higher risk for later educational drop-out
Key measures

- **Mathematical skills** (Math Achievement Test, Stage I, Grades 1 to 3)
  - Basic arithmetic skills
  - Measurements
  - Applied arithmetic
  - Reasoning

- **Cognitive components** (Children and Adolescent Cognition Manual, National Children’s Study of China (NCSC), National Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University)
  - Short-term memory (STM I Visual Number Immediate Recognition; STM II Paired Association Immediate Recognition)
  - Attention
  - Visuo-Spatial Ability (VSA I Hidden Figures, VSA II Mental Rotation)
  - Long-term memory (LTM I Visual Number Delayed Recognition, LTM II Paired Association Delayed Recognition)
  - Reasoning (Reasoning I Digit Analogy, Reasoning II Graph Analogy, Reasoning III Graph Sequence)
Key measures

- **Motivational tendencies**
  - Value and expectancy beliefs
    - Utility, importance, interest
    - Competence, effort, anxiety
  - Achievement goal orientations
    - Mastery-intrinsic, mastery-extrinsic, performance-approach, performance-avoidance, work avoidance
  - Control beliefs
    - Agency beliefs
    - Means-ends beliefs

- **Well-being**
  - Fear of failure
  - Academic withdrawal
  - Self-esteem
  - School value
  - Emotional exhaustion
  - Perfectionistic tendencies
    - Standards, discrepancy, expectations

- **Temperament**
  - Behavioral inhibition, behavioral approach, reward seeking
## Procedure and updated timetable

<table>
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<tr>
<th>Schedule</th>
<th>Procedure</th>
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<td>November 2016</td>
<td>Piloting of the measures</td>
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<tr>
<td>November &amp; December 2016</td>
<td>Research permits from communities, schools and parents</td>
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<tr>
<td>January &amp; February 2017</td>
<td>Data collection – first phase</td>
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<tr>
<td>March 2017</td>
<td>Data coding</td>
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<td>April – June 2017</td>
<td>Results from the first phase</td>
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<td>December 2017 &amp; January 2018</td>
<td>Data collection – second phase</td>
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<td>December 2018 &amp; January 2019</td>
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<td>December 2019 &amp; January 2020</td>
<td>Data collection – fourth phase</td>
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Take home message

• The joint effects of skill and will on learning are complex and challenging to detect, yet a necessary task for understanding the big picture

• Developmental analyses within a design that includes various types of key constructs are imperative

• Close collaboration with schools and parents is a necessity
Take home message

- Expected key outcomes and implications:
  - Increases our – and thus teachers’ – understanding of various factors contributing to students’ math learning
  - Produces knowledge that will help teachers to provide the students with more personalized support for successful learning