Journey through space
Can an in- and outside school science program improve children’s scientific reasoning?

Carla Geveke
Outline

• Introduction
• Theoretical framework: stimulating S&T, learning and teaching, scientific reasoning and knowledge declarations
• Research questions
• Method: multiple case study, microgenetic measures
• Results
• Conclusion & Discussion
Introduction

- The **aim** of this study is to investigate the quality of an in- and outside school science program by observing teaching and learning.

- This study focuses on the Mobile Planetarium.
Stimulating S&T in and outside school

Why stimulate S&T?

Young children are curious about scientific phenomena, but unfortunately too few finally graduate in S&T

Why outside school activities?

Provide exciting, real-world-experience which enhances motivation for and knowledge of science and establishes a more positive relation with science

Why connect with curriculum?

Children benefit more if they learn within various contexts
Learning and teaching in scientific reasoning

• Curiosity is conditional for deep learning
• Performance is dynamic
  – depends on context: importance of teacher’s support
  – Takes the form of co-construction
• Asking thought-provoking questions, encouraging to think out loud, and providing time-to-think induce change in conceptual knowledge
Scientific Reasoning and Knowledge Reproduction

Scientific reasoning: (change in) understanding of specific scientific phenomena as an aspect of cognitive development

Declarative knowledge: recall of factual information, traditionally defined as knowing ‘that’, or ‘knowing about’
Research questions:
1) How do children’s performances and teacher’s support change over time? To what extent do the various cases differ?
2) Does the magnitude of change in performance relate to the quality of the program implementation?
The aim of this study is to investigate the quality of an in- and out-of-school science program by observing teaching and learning.

Research questions:
1) How do children's performances and teacher's support change over time? To what extent do the various cases differ?
2) Does the magnitude of change in performance relate to the quality of the program implementation (rank and support)?

Hypothesis 1: Performance increases as a result of more support; most salient in an optimal case.

Hypothesis 2: Trained teachers show more support than untrained teachers, and their children show better performance.

Hypothesis 3: Effect of Program is proportional to the quality of its implementation.
Cases

• In-depth study of four cases: optimal, semi-optimal (2) and marginal
  – Optimal: trained teachers; sequence: preparation-visit-consolidation-follow-up
  – Marginal: untrained teachers; sequence: visit-consolidation-follow-up
  – Lessons can be ranked on basis of the implementation quality

• Upper grade classes
Expectations optimal performance/support

<table>
<thead>
<tr>
<th>Children/Teacher</th>
<th>Increase</th>
<th>Equal</th>
<th>Decrease</th>
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<tbody>
<tr>
<td>Scientific Reasoning</td>
<td><img src="#" alt="Graph" /></td>
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<td>Knowledge Reproduction</td>
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**Legend:**
- green = optimal
- Orange = semi
- Red = marginal
Procedure and analysis

- Two lessons of each case are videotaped
- Transcription of utterances of first 800 seconds/lesson
- Coding:
  - children’s complex thinking with Skill Theory and coding of Scientific Reasoning / Knowledge Reproduction;
  - teacher’s style with Openness Scale and coding of Evoking Scientific Reasoning / Evoking Knowledge Reproduction
Example of resulting time-series
Coding

Optimal complex thinking = Scientific Reasoning- Knowledge Reproduction

Optimal Openness = Evoking Scientific Reasoning- Evoking Knowledge Reproduction
H1: support and performance?

<table>
<thead>
<tr>
<th></th>
<th>Case 1 (optimal)</th>
<th>Case 2 (semi-optimal)</th>
<th>Case 3 (semi-optimal)</th>
<th>Case 4 (marginal)</th>
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<tr>
<td><strong>Increase Optimal Openness (support)</strong> [ESR-EKR]</td>
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<td><strong>8 (5-5)</strong></td>
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<td><strong>12 (14-2)</strong></td>
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<td>[23-20]-[15-20]</td>
<td>[11-32]-[41-18]</td>
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</table>
H2: better performance by trained teachers?

P-value < 0.01

1-9-2014

CM trained

CM untrained

Optimal Complex Thinking

Optimal Openness

P-value < 0.01
H3: Is the effect of the Program proportional to the quality of implementation?

- Correlation: support - quality rank sessions  $r = 0.5$ ; p-value = 0.10
- Correlation: performance - quality rank  $r = 0.42$; p-value = 0.16
Conclusion

1) How do children’s performances and teacher’s support change over time? To what extent do the various cases differ?
   - Optimal case shows an increase in support and in performance

2) Does the magnitude of change in performance relate to the quality of the program implementation?
   - The exists a positive relationship between performance and quality of implementation
   - The optimal case shows better results than other cases: preparation and training of teachers is advisable
Discussion & Questions

- How is CM support of teachers and performance children related over time, if inspected microgenetically?
- What are the properties of optimal support and performances?