ELEMENTARY SCHOOL SCIENCE: IMPLEMENTATION OF DOMAIN-GENERAL STRATEGIES INTO A TEACHING DIDACTICS

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The Effectiveness of Science Learning Interventions in Primary Education

Introduction & motivation

Elementary science education = dynamic interaction of

- domain-specific knowledge of concepts
- domain-general strategies of problem-solving

(among others: Klahr, Zimmerman & Jirout, 2011)

→ unusual in Flemish education system

↓ *why?*

underestimation of children's abilities

↓ *consequence?*

also lacking within teacher training, especially with regard to didactics

⇨ Implementation of **domain-general strategies** in teaching didactics for elementary science

+ relationship (meta)cognitively inspired programmes and **attitudinal developments**

Didactics for elementary science

➔ **dynamic interaction of**

- domain-specific knowledge of concepts
- domain-general strategies of problem-solving

➔ **3 types of scientific processes**

1. Forming hypotheses
2. Experimenting
3. Evaluating evidence

➔ **content embedded in a metacognitive structure**

➔ **learning in a social context**

Didactics for elementary science

➔ **content embedded in a metacognitive structure**

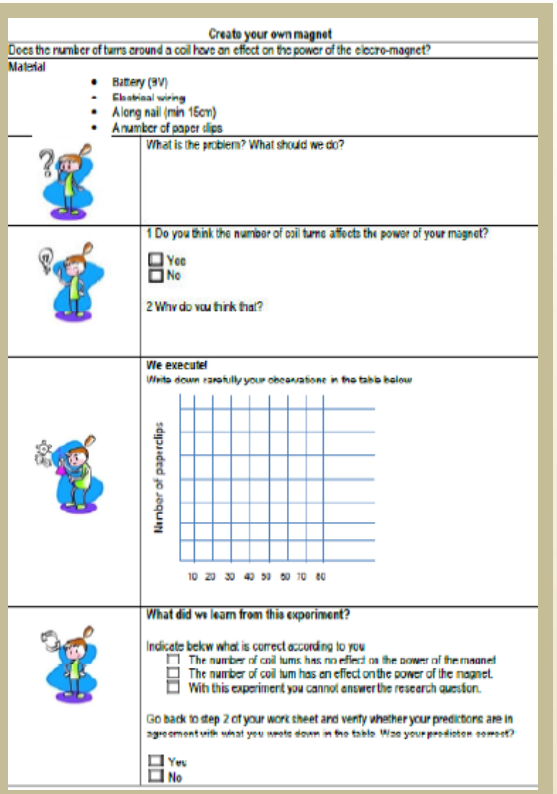
↓ *why?*

focus attention more selectively on the ongoing processes
offer a procedural routine for scientific problem solving

(among others: Schraw, Crippen & Hartley, 2006)

→ cyclic step-by-step plan of 4 phases:

1. Oriëntation
2. Exploration
3. Execution
4. Evaluation



⇨ Study: 2-month (meta)cognitively inspired hands-on programme about 8 scientific content domains with children of 11-12 year old

Design & procedure

➔ **Introduction session for teachers** (pre- and in-service teachers)

- Questionnaire: confidence levels for science, ICT …

Group: Control [84]– Experimental [260]
Gender: Male [182] – Female [162]
Grade: 5th (11) [167] – 6th (12) [177]
Teacher: Pre-service (20) [172] – In-service (41) [172]

➔ **Pre-test phase** (within 2 weeks after the introduction session)

- Judgement task: domain-general strategy for designing unconfounded experiments (causal interference)
- Questionnaire: attitudes towards sciences (among other factors: what I really think of science) (Jarvis & Pell, 2002)

➔ **Instruction phase** (2 weeks after the introduction session)

➔ **Post-test phase**

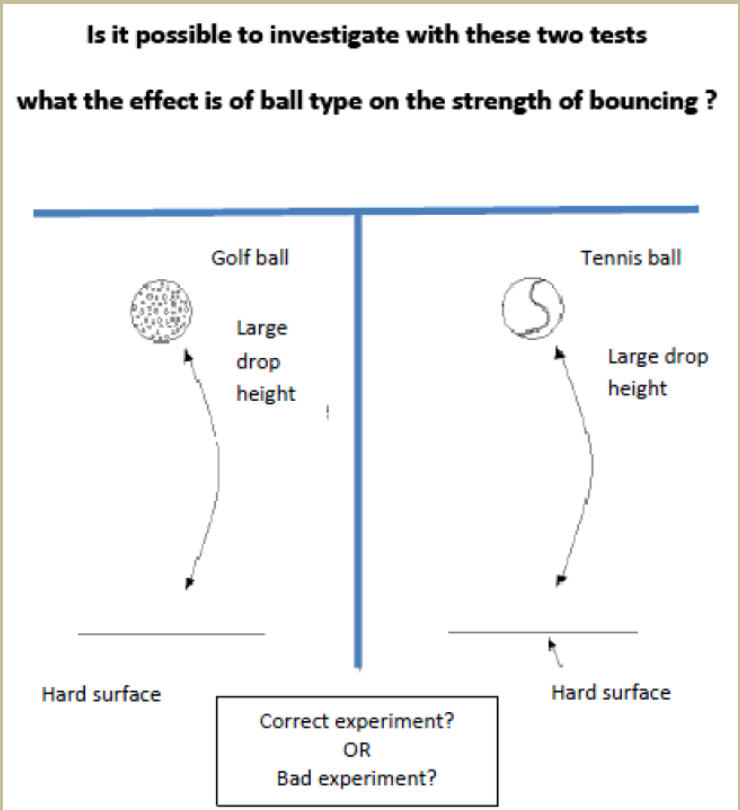
- Judgement task: domain-general strategy (ditto)
- Questionnaire: attitudes towards sciences

(one week after instruction phase)

- 2 hands-on experiments (slope): domain-general strategy (ditto) + time (indirect: metacognitive awareness)

(with limited number of 12-year old children – in-service teachers) (2 weeks after instruction phase)

Design & procedure



Judgement task

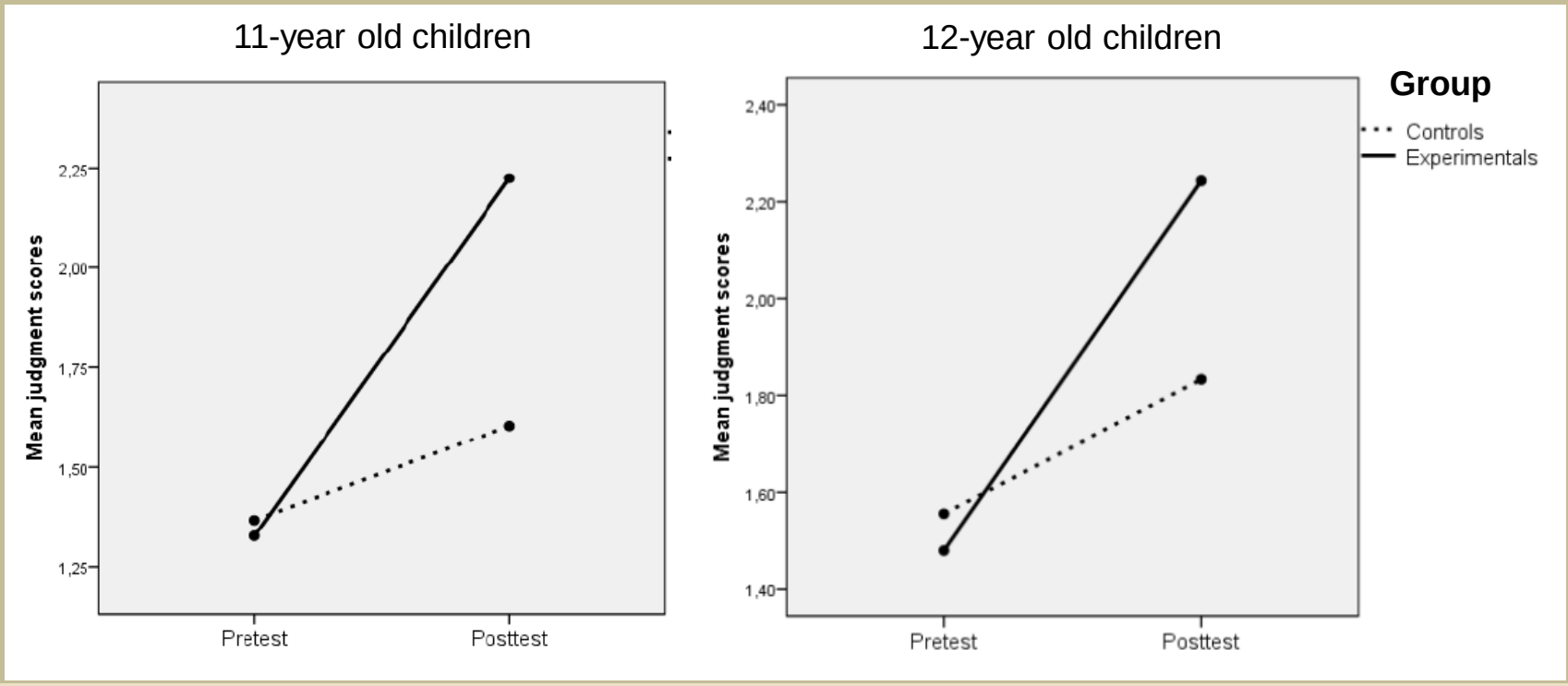
Factor 3 *What I really think of science*
Science Enthusiasm
RT1 I should like to be a scientist.
RT2 I like science more than any other school work.
RT3 I often do science experiments at home.
RT4 I like to watch science programmes on TV.
RT5 School science clubs are a good idea.
RT6 I'm always reading science stories.
RT7 I should like to be given a science kit as a present.
RT8 One day, I would like to go to the moon.
Chronbach's Alpha
Social Context
RT9 Science is good for everybody.
RT10 Lots more money should be spent on science.
RT11 It is easy to find out new things in science lessons.
RT12 Science has made us better and safer medicines.
RT13 TV, telephones, and radio have all needed science.
RT14 Our food is safer thanks to science.
RT15 Science makes me think.

Attitude questionnaire (based on Jarvis & Pell (2002))

Results & discussion

1. Strategy for scientific thinking

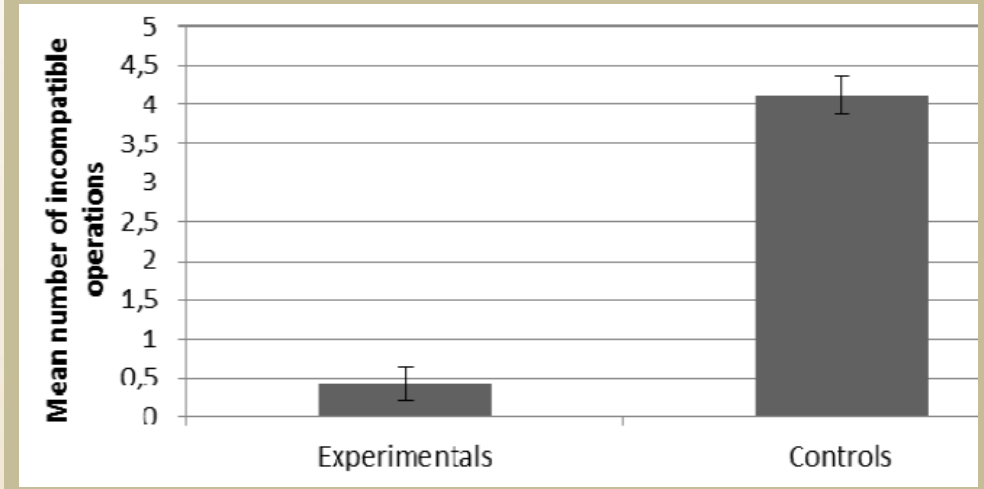
└ based on judgement tasks

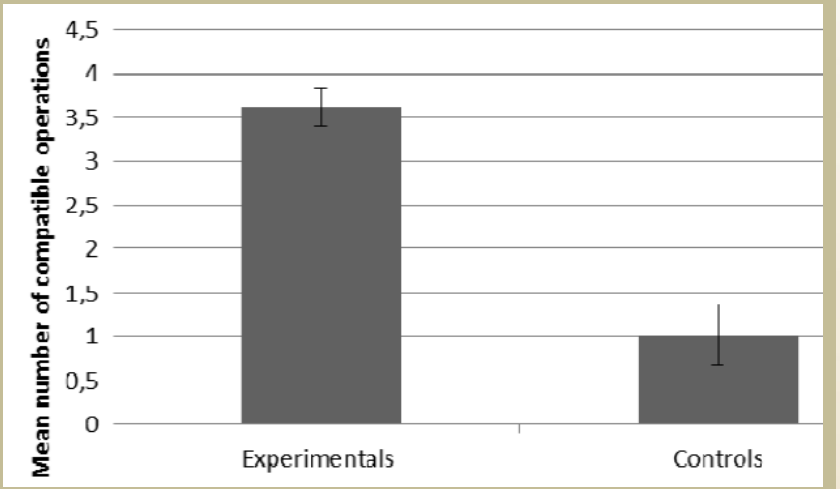


Results & discussion

1. Strategy for scientific thinking

└ based on 2 hands-on experiments (12 year old children – in-service teachers)





⇨ Explicit training in experimenting

→ better understanding of experimenting and more transferring to other domains

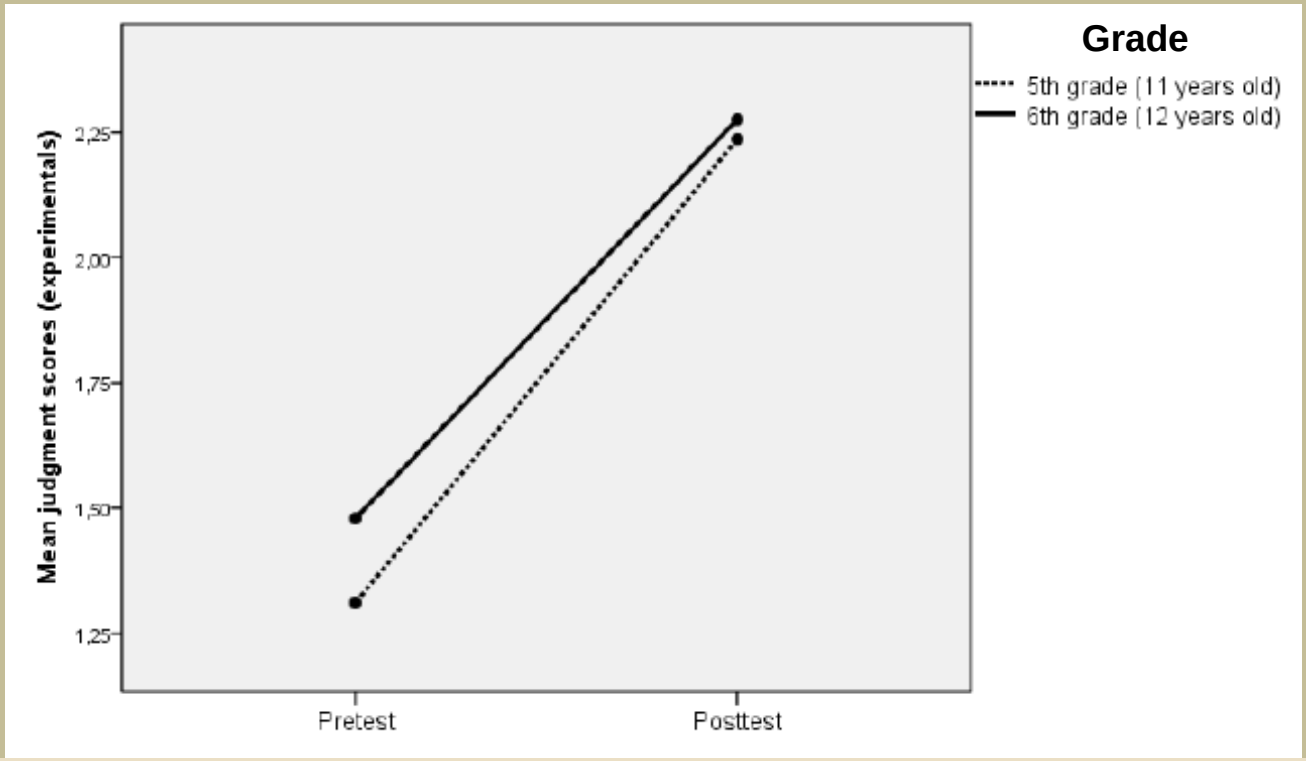
(among others: Chen & Klahr, 1999)

⇨ For young children?

Results & discussion

1. Strategy for scientific thinking

└ based on judgement tasks

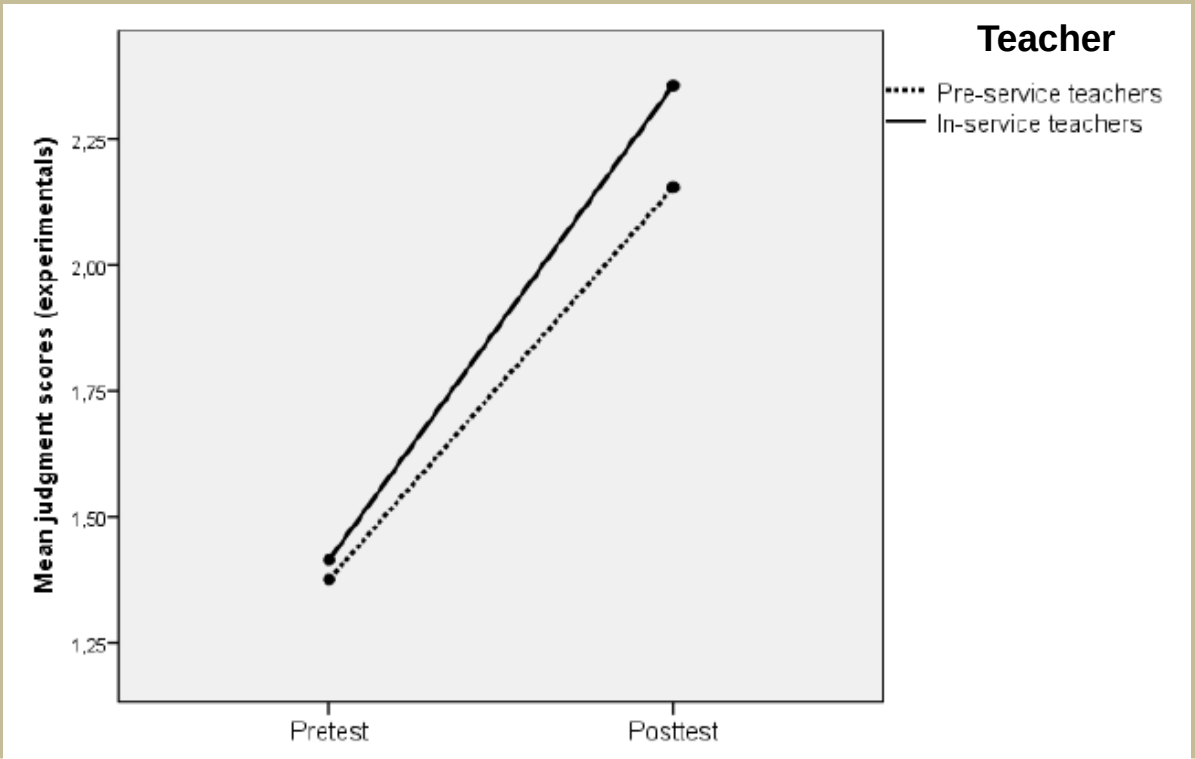


Lowering attitudinal trend at the end of primary school
(among others: Murphy & Beggs, 2003)

Results & discussion

1. Strategy for scientific thinking

└ based on judgement tasks



Lack of pedagogical content knowledge (among others: Botha & Reddy, 2011)

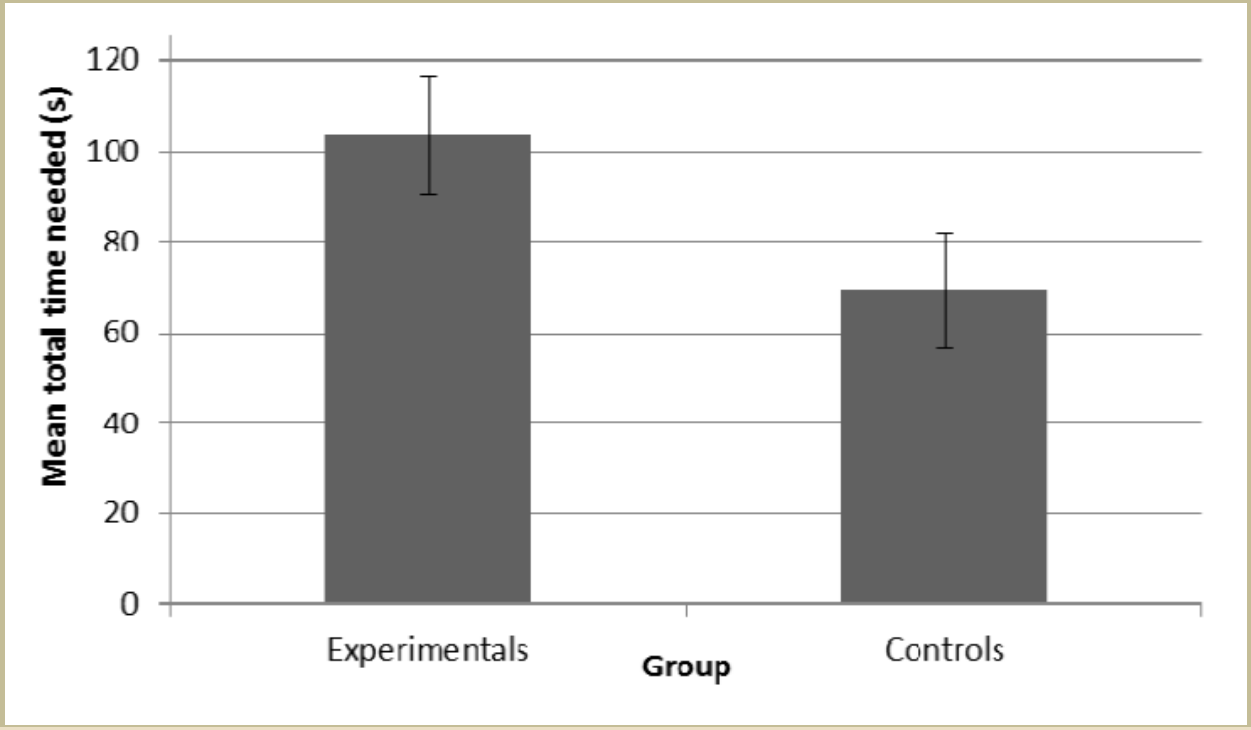
Less confident in sciences

└ based on questionnaire

Results & discussion

2. Time as indirect measurement for metacognitive awareness

└ based on 2 hands-on experiments (12 year old children – in-service teachers)



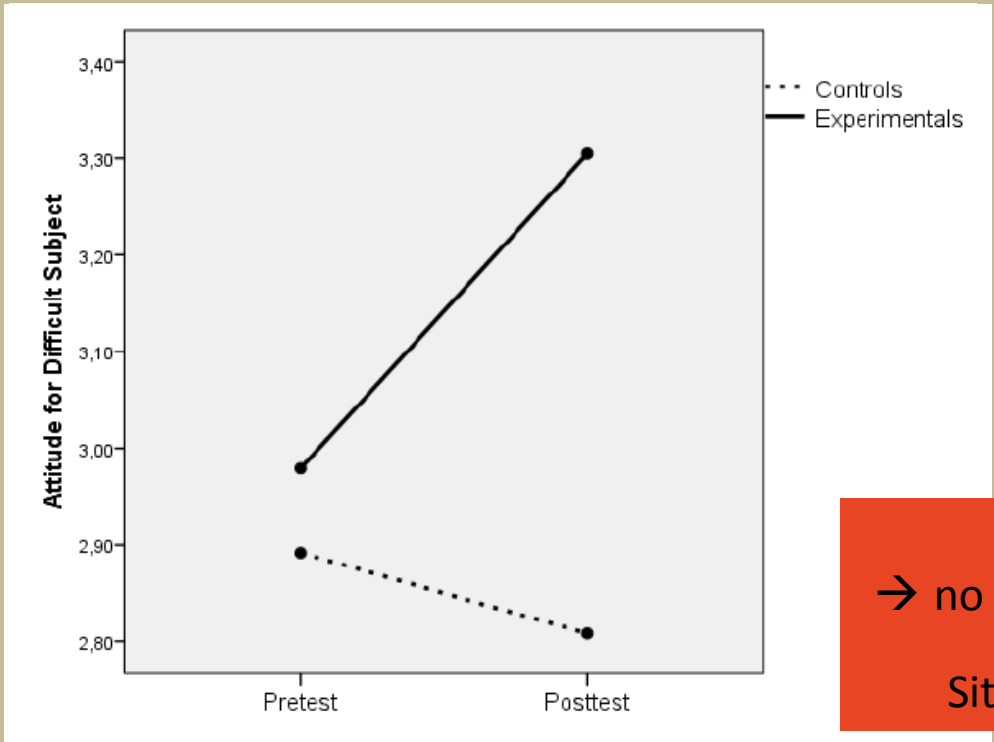
Inhibition of impulsive behaviour

(among others: Kamann & Wong, 1993)

Results & discussion

3. Attitudes towards sciences

└ based on attitude questionnaire



Reasons within the programme?

- Excitement & positive responses
- Effective programme according to Schraw, Crippen & Hartley (2006)

Reasons outside of the programme?

- Lowering attitudinal trend at the end of primary school
- Emerging of a more realistic view of science

(among others: Jarvis & Pell, 2002)

⇨ Hands-on experimenting

→ no automatical effect for positive attitude

(among others: Abrahams, 2008)

Situated interest vs. personal interest

Conclusions

→ **More effective scientific problem solvers**

→ better performance with regard to the process and strategy of scientific thinking

→ in-service teachers attained a stronger learning effect (more confidence)

→ 6th graders performed better, but 5th graders obtained stronger learning gains

→ 6th graders showed metacognitive awareness in hands-on experimenting

→ possible to stimulate problem-solving without excessive focus on strategies

→ **No automatical development of positive attitudes**

→ drop of enthusiasm for science

→ science is seen as less difficult

→ caution with regard to claims about attitudes based on hands-on experimenting

THANK YOU FOR YOUR ATTENTION

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