CONCEPTUAL UNDERSTANDING OF SCIENTIFIC IDEAS THROUGH DIALOGUE AND EXPERIMENT

Facilitating concept building in natural sciences for first grade secondary school pupils in a laboratory setting

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Explaining Nature
Explaining Nature, a metaphor

Initial

Explanations based on preconceptions

Desired

Explanations based on scientific models
Explaining Nature
‘the classic approach’
Belgium  
≈50% of pupils reaches minimum standards (MS)  
< 30% reach MS on “Energy”

Spain  
2006: introduction of the competence based model  
<->  
No significant increase in PISA test scores

Lesotho  
“Some teachers attributed the learners’ difficulties in understanding science topics to inadequate knowledge of English language, which makes learners not to be able to express themselves when answering science questions.”

Achievement measurement on minimum standards in first grade secondary science education commissioned by the Flemish government (R. Janssen, E. Ameel, D. Van Nijlen, 2016)  
GEMS Lesotho Report commissioned by the ministry of education (Mokuku et al. 2013)  
Research Questions

• How must a methodology be designed to stimulate, through incorporation of dialogical learning, an integrated approach and explicit attention to misconceptions, the formation of scientific concepts?

• What is the attitude of the teachers and students that are involved?

• Which factors facilitate or inhibit the introduction of the methodology in the classroom?

• What is the impact on the scientific concept knowledge?

• To which extend impact cultural factors the methodology?
Design based research

**Problem**

**Methodology**

**Results**

**Plans**

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WP 3: Ontwikkeling

- Onderzoekscyclus 1.1: Professionele leergemeenschap
  - 5 leerkrachten: 6 samenkomsten

  **Ideeënfabriek Versie 1**

- Onderzoekscyclus 1.2: try-out bij studenten in de lerarenopleiding

**WP 4: Try-out**

- Onderzoekscyclus 2.1: Try-out (5x2u) door 5 leraren

  **Ideeënfabriek Versie 2**

- Onderzoekscyclus 2.2: Professionele leergemeenschap in Lesotho & Spanje

**WP 5: Impact**

- Onderzoekscyclus 3.1: Try-out (10x4u) door 10 leerkrachten Lesotho & Spanje

- Onderzoekscyclus 3.2: Try-out (5x2u) door 5 studenten

- Onderzoekscyclus 3.3: Try-out (10x4u) door 10 leerkrachten Lesotho & Spanje

**Finale Ideeënfabriek**
Approach

Integration of science content

Explicitation of preconceptual understanding

Socratic dialogue

Fol

Project 2061, Karno, Dewey, Vygotsky, Galperin, Alexander, McDermott, Viennot, Guisasola, …
Explaining Nature ‘the Fol approach’

Phase 1: the preconcept
- Wake up
- Identify
- Shake

Phase 2: the scientific concept
- Introduce
- Secure
- Use
Wake-up

What?

Different ideas exist!

How?

Concept cartoon, classify, odd one out,...

What did we observe?

Dialogue

What does .... mean to you? What do you mean by that? Do you think this or do you know this? Do I understand correctly that .... Does everybody think the same? Is what way is your idea different?

“You can not say what ideas of students are good or bad. A teacher said that one thing was correct and I immediately saw the reaction of the other students. They took over that answer or withdrew their opinion.”

*Translated from a student second year teacher training*

Experiment

Example
Wake-up
Identify

What?

Which idea to target?

How?

Dialogue, concept-tests, demo-experiment to clarify

What did we observe?

Dialogue

What do we disagree on? What topic needs further investigation? Does the whole class agree that …. is unclear?

Experiment

Example
“Some of us think that only moving things have energy, some of us think that only living things have energy, some of us think that everything has energy.”

http://assessment.aaas.org/topics/
Shake

What?
Discrepant event

How?
Demo-experiment, laboratory exercises, “magic”, ...

What did we observe?

Dialogue
Does this test what we are trying to examine? Does this show what you are saying? How is this possible? How does this work? Can you explain what is going on?

Experiment

Example

Longfield, 2006
Shake
Introduce

What?

present scientific view

How?

simulation, Lecture

What did we observe?

Dialogue

This is the scientist's opinion.

Experiment

Example
Secure

What?
Students experiment to check the science

How?
Through laboratory experiments
if possible: experiments devised by the students

What did we observe?

Dialogue
Does this test what we are trying to examine? Does this show what you are saying?
How is this possible? How does this work? Can you explain what is going on?

Experiment

Example
Secure

*What properties might contribute to the energy of an object?*

*Can you show me in an experiment?*
Use

What?

Apply in a new situation

How?

Different experiment, true or false (discuss), what if, activity,...

What did we observe?

Dialogue

Does this test what we are trying to examine? Does this show what you are saying?
How is this possible? How does this work? Can you explain what is going on?

Experiment

Example
Use

What if humans could perform photosynthesis all of a sudden?
What if we could not store energy?

...
Design-based research

WP 3: Ontwikkeling

WP 4: Try-out

WP 5: Impact

RC 1

Development (BE)
- 3 Teacher Training sessions
- 2 High school classes
- Qualitative

RC 2

Try out
- Lesotho (3 SET)
- Spain (1 TT + TTS)
- Belgium (3 TT + TTS + 5 SET)
- Qualitative
- Development and tryout of tests for quantitative approach

Data collection

Impact?
- Lesotho (3 SET)
- Spain (1 TT + TTS)
- Belgium (3 TT + TTS + 5 SET)
- Quantitative
- Control classes
Discussion

WG₄ (tomorrow)

- ...
- Use of dialogue in science education
- Role of the teacher (during laboratory work)
- ...
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