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

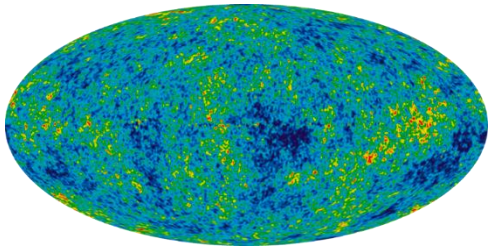
Jan Sermeus, Wim Temmerman, Jelle De Schrijver, Christel Balck (Odisee university college, Belgium)

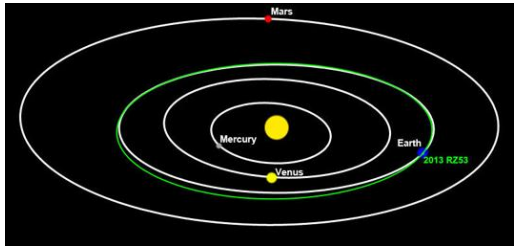
Tsepo Mokuku (National university of Lesotho, Lesotho)

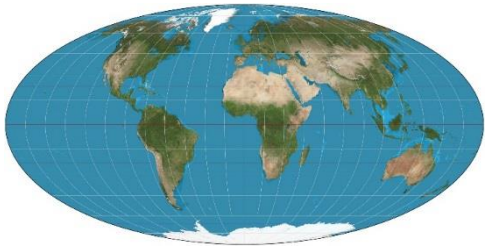
Beatriz García Fernández (University of Castilla-La Mancha, Spain)

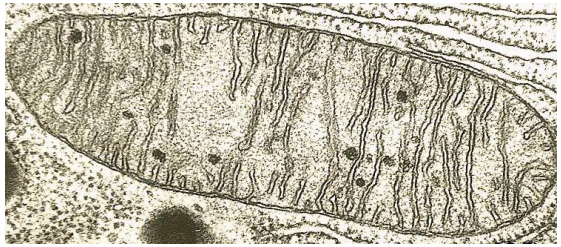
Ideeënfabriek
Factory of Ideas

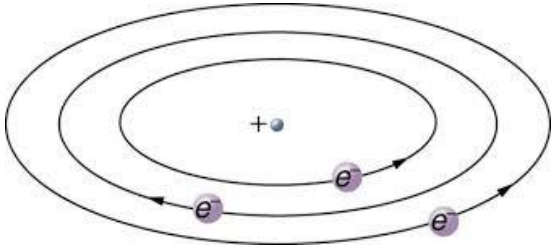
Explaining Nature











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Explaining Nature, a metaphore

Initial

Explanations based on preconceptions

Desired

Explanations based on scientific models

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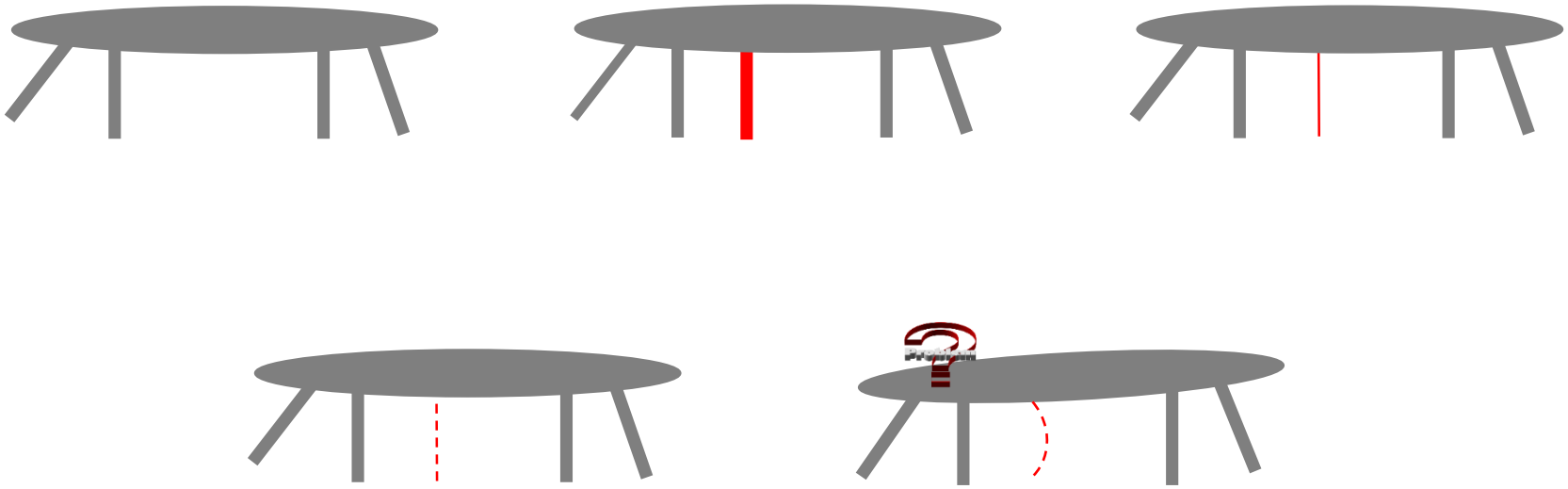
Explaining Nature
'the classic approach'



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 Flemisch government (R. Janssen, E. Ameel , D. Van Nijlen, 2016)
GEMS Lesotho Report commissioned by the ministry of education (Mokuku et al. 2013)
How Spanish science teachers percieve the introdution of competence-based science teaching. (Mateos Jiménez, A., García Fernández, B., & Bejarano Franco, M. T. , Journal of Baltic Science Education, 1(15), 371-381, 2016)

Research Questions

- How must a methodology be **design**ed 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?

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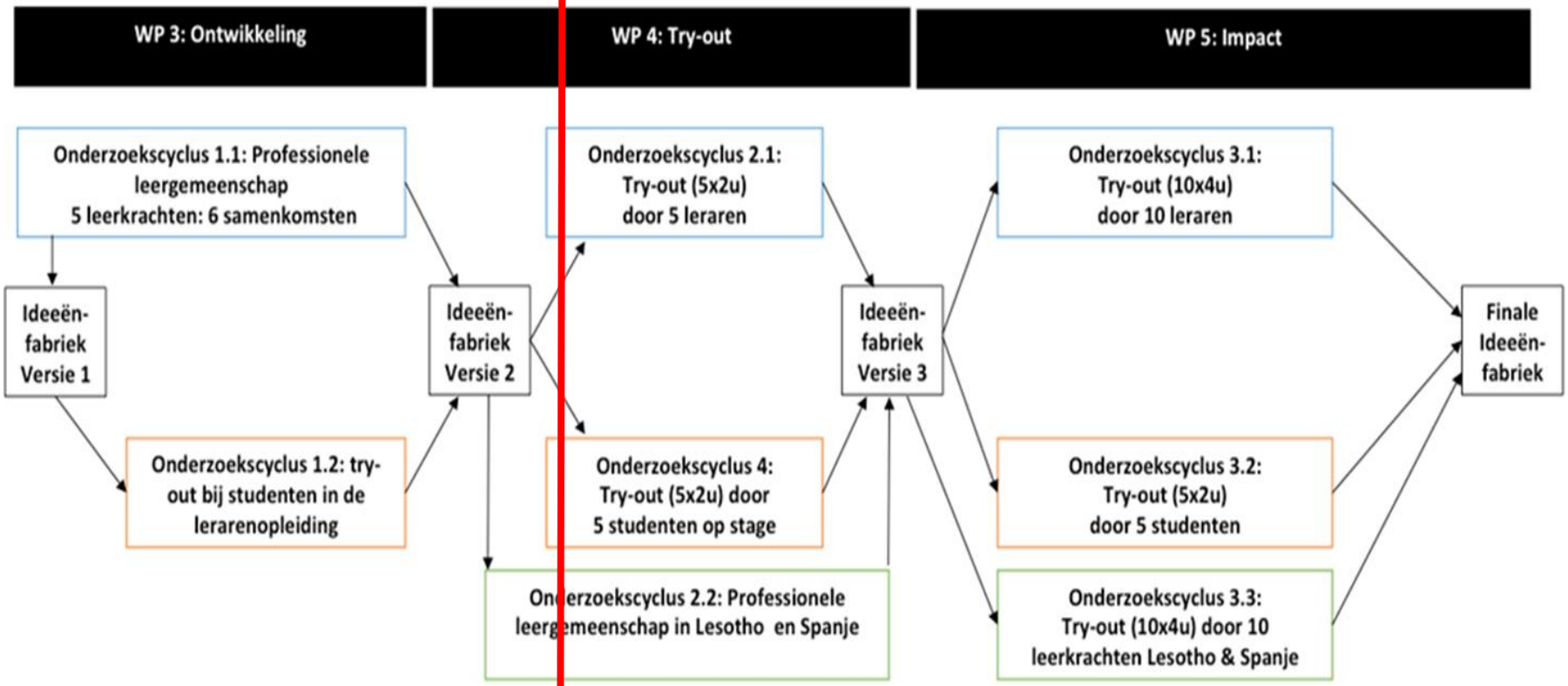
Design based research



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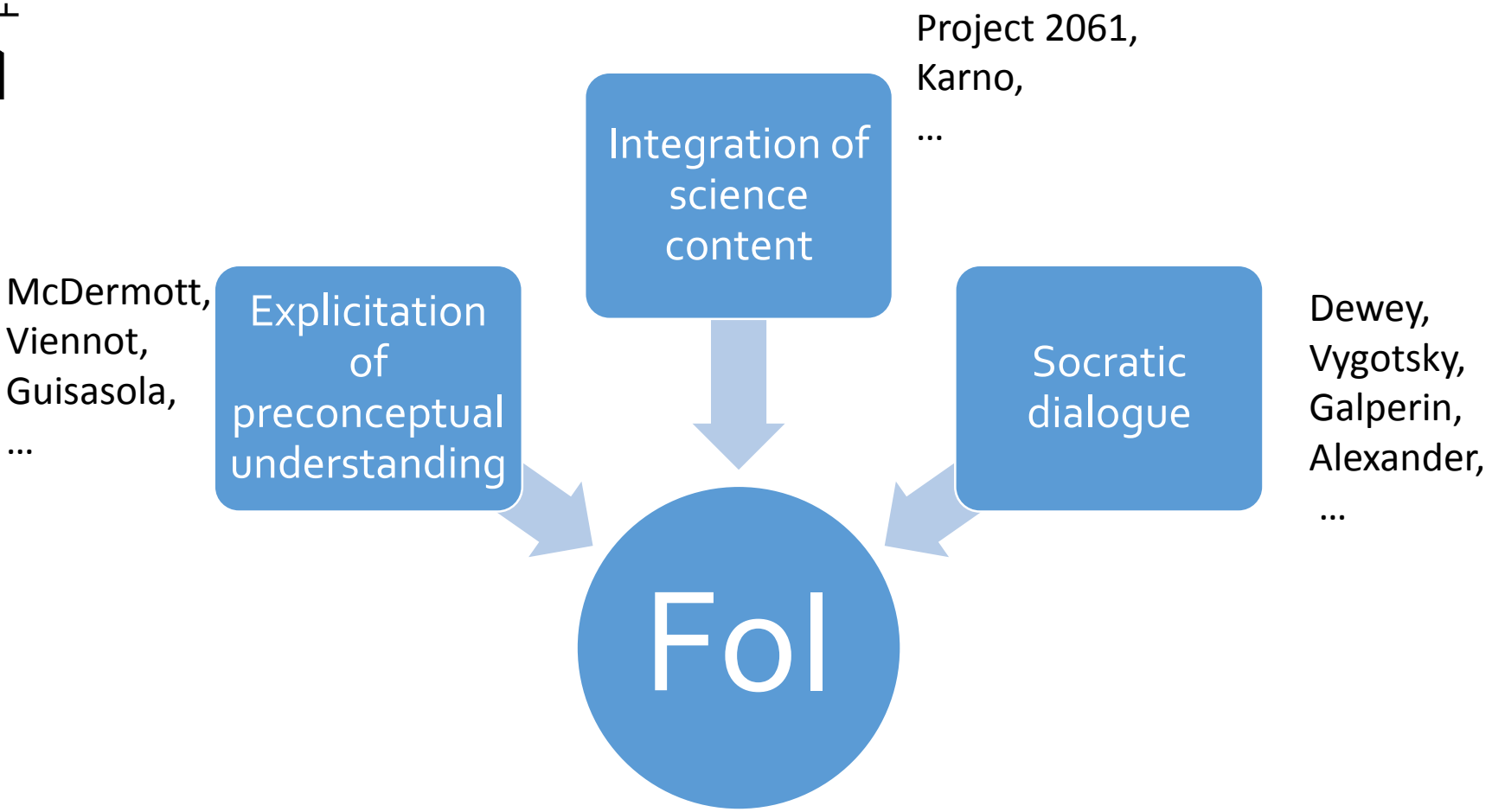
Approach



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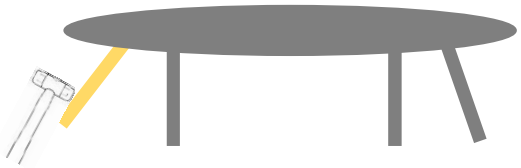
Explaining Nature
'the FoI approach'

Phase 1: the preconcept

Wake up

Identify

Shake



Phase 2: the scientific concept

Introduce

Secure

Use

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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

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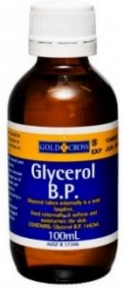
Wake-up



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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

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Identify



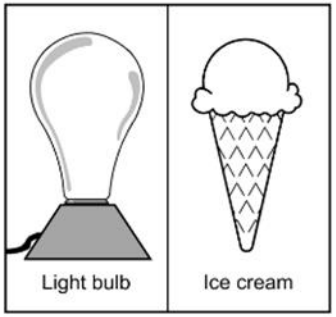


"Some of us think that … have energy, some of u…

Item NG045002: Both a light bulb and an ice cream cone radiate energy because all objects radiate energy.

« Previous Item: NG022003

Consider a light bulb and an ice cream cone.



Which gives off energy by radiation and why?

A. Both a light bulb and an ice cream cone because all objects radiate energy
B. Neither a light bulb nor an ice cream cone because only the sun radiates energy
C. Only a light bulb when it is glowing because only glowing objects radiate energy
D. Only a light bulb when it is hot because only hot objects radiate energy

Item Details | Student Performance

Topic

Energy: Forms, Transformation, Transfer, and Conservation

Correct Answer

A

Misconceptions

Answer Choice: B

NGM036: Only the sun transfers energy in the form of electromagnetic radiation (AAAS Project 2061, n.d.).

Answer Choice: C

NGM031: Only objects that are glowing can transfer energy in the form of electromagnetic radiation (AAAS Project 2061, n.d.).

Answer Choice: D

NGM032: Only hot objects can transfer energy in the form of electromagnetic radiation (AAAS Project 2061, n.d.).

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

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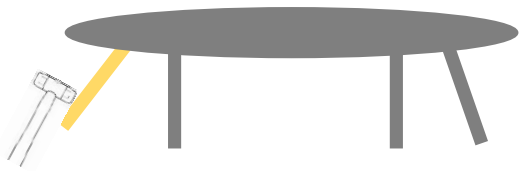
Shake



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

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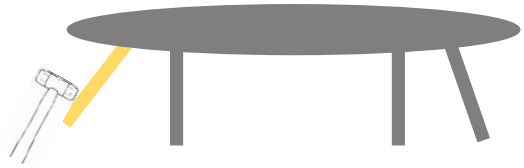
Shake



Introduce

What?

present scientific view

How?

simulation , Lecture

What did we observe?

Dialogue

This is the scientists opinion.

~~Experiment~~

Example

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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

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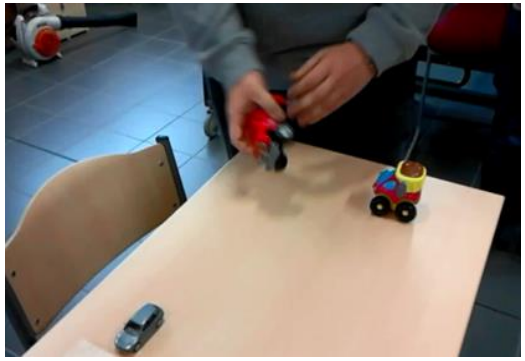
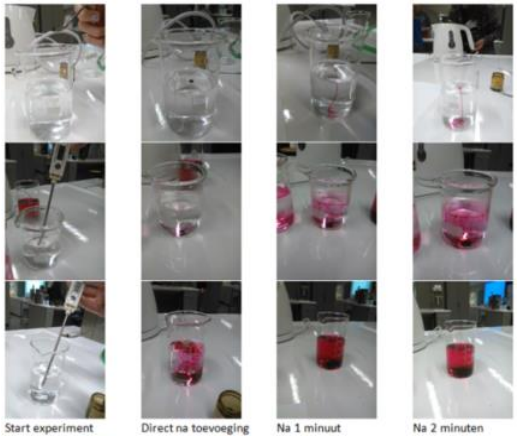
Secure

What properties might contribute to the energy of an object?

Can you show me in an experiment?





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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

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Use

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

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Design-based research

RC 1	RC 2	Data collection
Development(BE) - 3 Teacher Training sessions 2 High school classes - Qualitative	Try out - Lesotho (3 SE T) - Spain (1 TT + TTS) - Belgium (3 TT + TTS + 5 SE T) - Qualitative - Development and tryout of tests for quantitative approach	Impact? - Lesotho (3 SE T) - Spain (1 TT + TTS) - Belgium (3 TT + TTS + 5 SE T) - Quantitative - Control classes

Discussion

WG4 (tomorrow)

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

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UCLM UNIVERSIDAD DE CASTILLA-LA MANCHA