



CONCEPTUAL UNDERSTANDING OF SCIENTIFIC IDEAS THROUGH DIALOGUE AND EXPERIMENT: A follow up

*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)



GIREP-ICPE-EPEC 2017



3rd-7th July 2017,
Dublin City University, Dublin, Ireland



Last year



GIREP 2016

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)



1



Follow up?

- A summary of the methodology
- Experimental design
 - Test
- Results
- Practice oriented output

Summary

stage (e.g. wake up)	
What will you do?	What will you say?
What can you expect?	
Warning!	

<http://assessment.aas.org/topics/>

Phase 1: the preconcept

Wake up

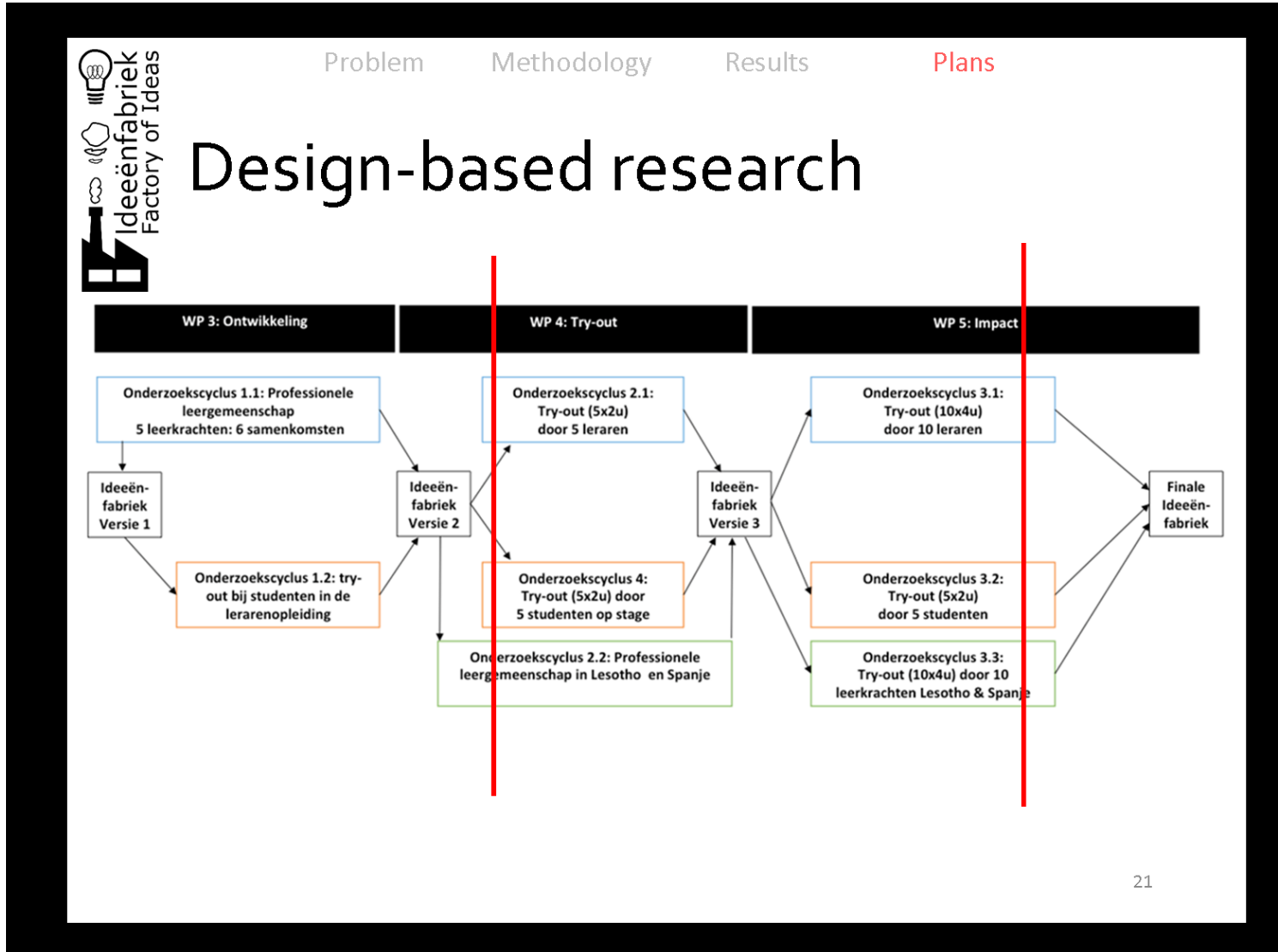


Phase 2: the scientific concept

Introduce



Experimental design



Experimental design

Quasi-experimental: Pre-post energy CU test

Convenience sample

$N = 148$ ($N_{\text{exp}} = 90$, $N_{\text{contr}} = 58$)

3 schools, 9 classes, 12-13 y

4h intervention

following 6 Fol steps

4h control

'good' classical class (lecture, student experiments)

Girep 2018?



Testing conceptual understanding energy

TEACHING AND LEARNING THE CONCEPT OF ENERGY IN PRIMARY SCHOOL

Paula Heron, Marisa Michelini and Alberto Stefanel

- Q1. What do you know about Energy?
- Q2. As far as you know, are there things that make energy?
- Q3. As far as you know, are there things that have/posses energy?
- Q4. Is energy conserved? In your answer explain in what is meant by “conserved.”
- Q5. Can energy by transformed? Explain, giving two examples
- Q6. Can energy be lost? Explain, giving two examples
- Q7. What types of energy do you know about?

Testing conceptual understanding energy

Heron, 2008











Name: _____
Date: _____

	I do not agree at all	I do not agree	Neutral	I agree	I agree completely
I understand the scientific concept of energy.					
I would like to have more science classes similar to the class on energy.					

What happens to the energy in the following scenarios?








A girl runs.	
A car drives.	
The blades of a windmill are turning.	
A cup of tea cools off.	

Name: _____

What creates energy? (mark correct answers with an "X", multiple are possible)		Please explain your answer
		
		
		
		

2

Name: _____

What possesses energy? (mark correct answers with an "X", multiple are possible)		Please explain your answer
		
		
		
		

















3

Name: _____

Q1. What do you know about energy? Write at least 3 sentences.
Q2. What types of energy do you know about?
Q3. Are there things that create energy? Explain by giving 2 examples.
Q4. Are there things that have/possesses energy? Explain by giving 2 examples.
Q5. Can energy be transformed? Explain by giving two examples.
Q6. Can energy be lost? Explain by giving two examples.
Q7. Is energy conserved? In your answer explain what is meant by "conserved."

4

What happens to the energy in the following scenarios?

<p>A girl runs.</p>	<p>What creates energy? (mark correct answers with an "X", multiple are possible)</p>		<p>Please explain your answer</p>		
<p>A car drives.</p>			<p>What possesses energy? (mark correct answers with an "X", multiple are possible)</p>		
<p>The blades of a windmill are turning.</p>					<p>Please explain your answer</p>
<p>A cup of tea cools off.</p>					<p>Please explain your answer</p>
					<p>Please explain your answer</p>
					<p>Please explain your answer</p>

Conservation + transformation of energy
 Creation + loss of energy
 Energy is a property of all things

Coding

2.1 pre	2.1 X	2.1 A	2.1 B	2.1 C	2.1 D	2.1 E	2.1 F	2.1 G	2.1 H	2.1 EXTRA	2.1 a	2.1 b	2.1 c	2.1 d	2.1 e	2.1 extra	1
girl runs	don't kno	property	change	everything	conservation	forms	converted	transmitted	stored	correct concept	living	moving	loss	creation	matter	misconception	g
/ (free co	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1		
a Een mijsje loopt.																	
Door het bi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bewegings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zie het k	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
ze heeft k	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kynetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Het mijsje	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Als het me	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
beweging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dat mijsje c	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ze heeft ki	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
De ketros	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ze wekt er	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haar licha	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
De kinetes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kinetische	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
De kinetes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Het voedsel	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Recht	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Licht mijsje	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Met energ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Voedsel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Voedsel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uit eten en	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
De energie	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Lichaamse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uit haar be	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Energie uit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haar licha	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

• Core concepts:

- Energy is a property
- Energy is a measure for possible change
- Everything has energy
- Energy is conserved
- There are different forms of energy
- Energy can be converted
- Energy can be transmitted
- Energy can be stored

• Misconceptions:

- Only living things have energy
- Only moving things have energy
- Energy can be lost
- Energy can be created
- Energy is a kind of matter

Results

Pictures: open answers

have	Pre		Post
control	0.43 ± 0.18	=	0.52 ± 0.17
	v *		^ **
experimental	0.08 ± 0.06	<***	1.31 ± 0.21

create	Pre		Post
control	1.65 ± 0.21	=	1.88 ± 0.23
	^ **		=
experimental	2.39 ± 0.17	>**	1.79 ± 0.18

Pictures

have			
control	4.33 ± 0.21	<*	4.72 ± 0.20
	=		^ **
experimental	4.18 ± 0.12	<***	5.67 ± 0.21

create	Pre		Post
control	4.03 ± 0.18	<***	5.50 ± 0.24
	=		=
experimental	3.96 ± 0.14	<***	5.07 ± 0.27

Open answers (Heron, 2008)

have	Pre		Post
control	0.10 ± 0.05	<*	0.28 ± 0.07
	=		^ ***
experimental	0.06 ± 0.03	<***	0.89 ± 0.10

create	Pre		Post
control	0.83 ± 0.08	=	0.84 ± 0.10
	^ *		=
experimental	1.14 ± 0.08	>**	0.81 ± 0.08

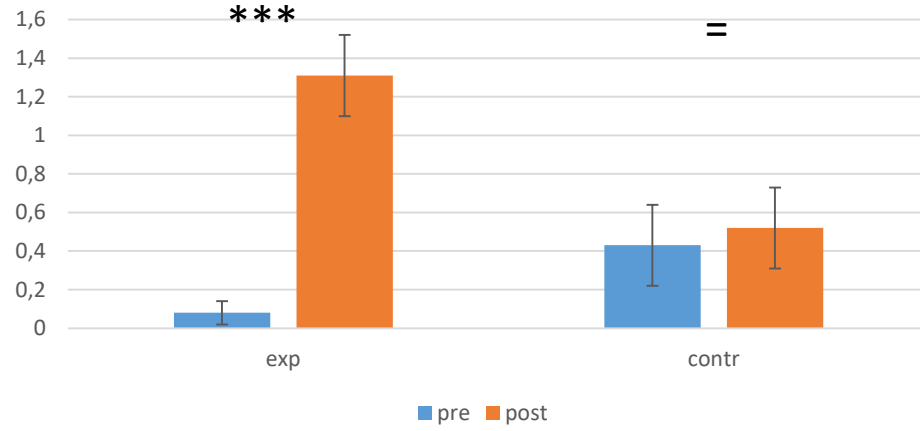
All tests show the same results

Increased understanding that everything has energy

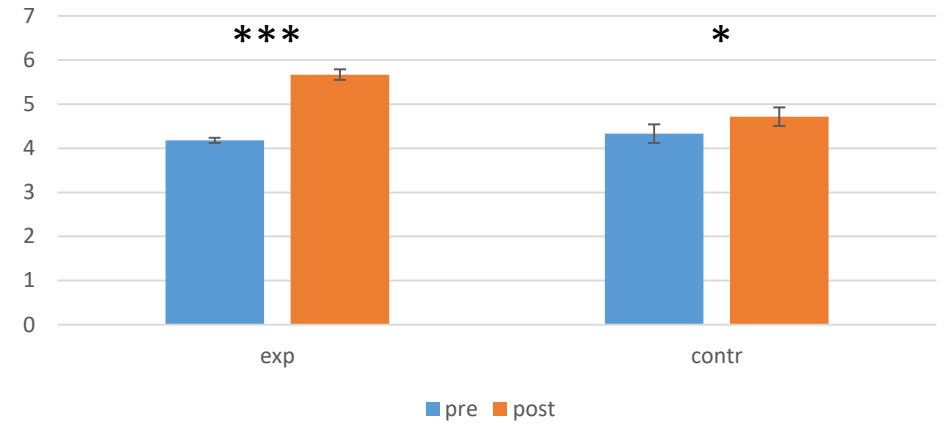
Unclear change in understanding that energy can not be created

*: p<0.05, **: p<0.01, ***: p< 0.001

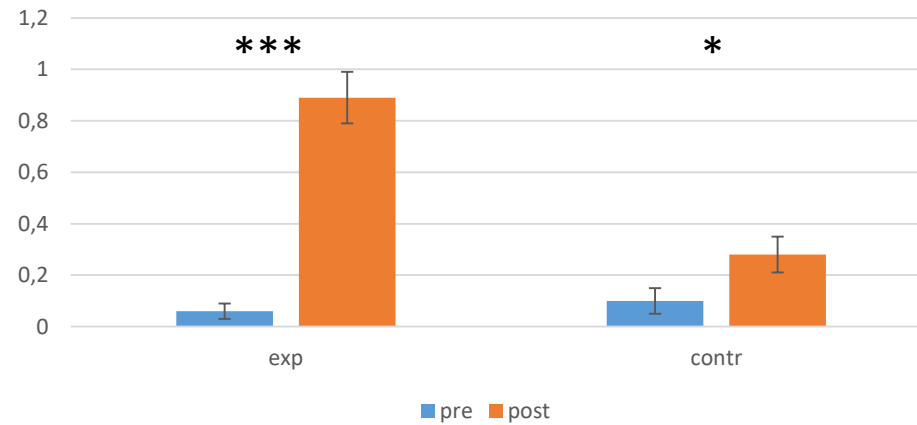
Open answers to pictures
Everything has energy



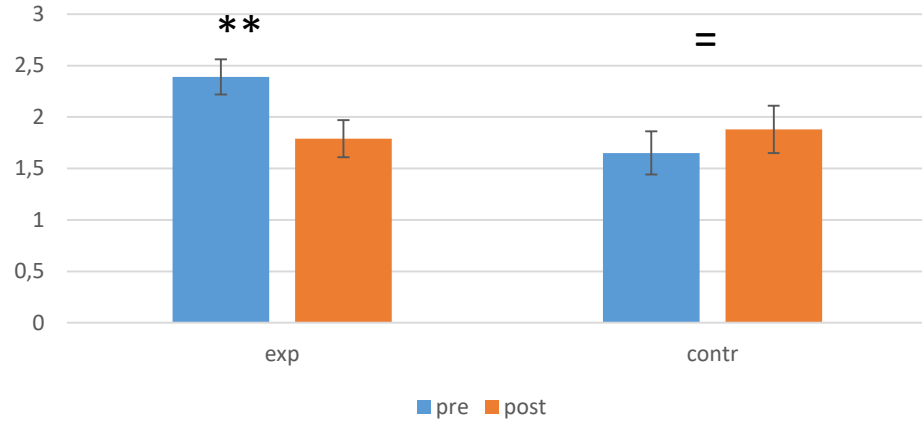
pictures
Everything has energy



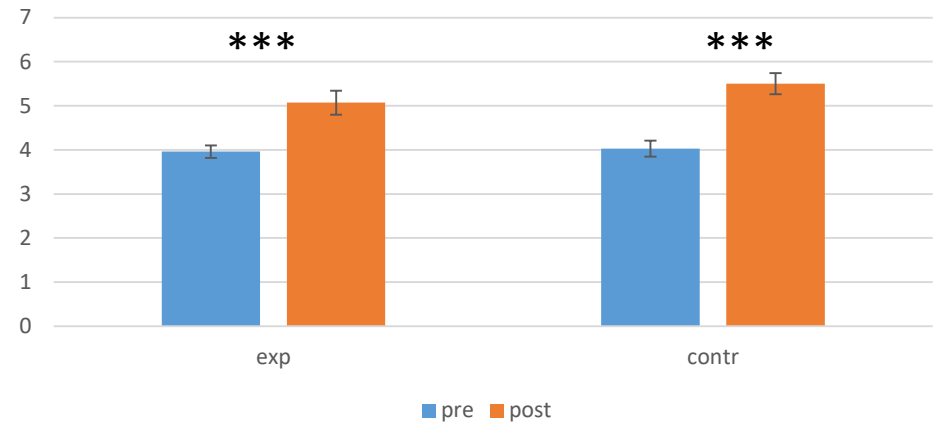
Open answers to Heron, 2008
Everything has energy



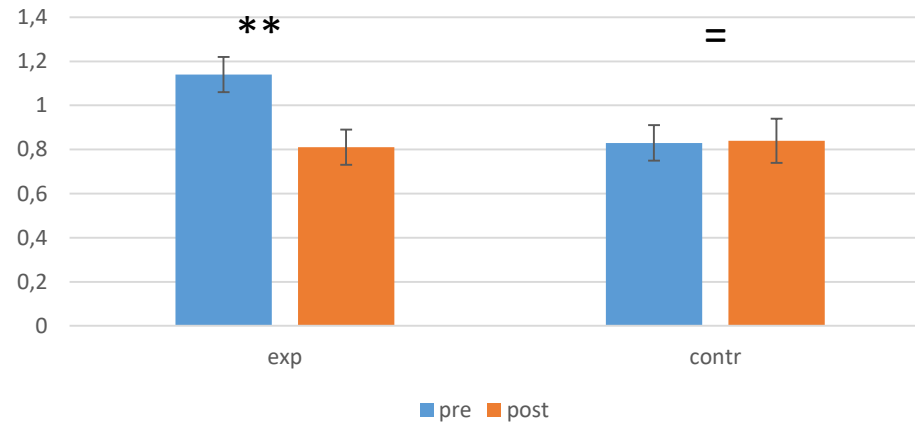
Open answers to pictures
Energy can be created



pictures
Energy can be created



Open answers to Heron, 2008
Energy can be created



Practice oriented output

- Pictures only test
- Lesson preparation template
- Website (under construction)
- Game
- Handbook



CONCEPTUAL UNDERSTANDING OF SCIENTIFIC IDEAS THROUGH DIALOGUE AND EXPERIMENT: A follow up

*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)



GIREP-ICPE-EPEC 2017



3rd-7th July 2017,
Dublin City University, Dublin, Ireland

