

Energy Concept in Primary Education

Josef Trna, Ivana Vaculová, Eva Ochrymčuková
Faculty of Education, Masaryk University
Brno, Czech Republic



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Energy in Physics

- We do not know what energy is, but we understand how to use energy effectively.
- "I can live with doubt and uncertainty and not knowing. I think it is much more interesting to live not knowing than to have answers that might be wrong."

DR. RICHARD P. FEYNMAN

Energy in Primary Education

Satisfactory concept of energy in the primary science education is not possible to create for two main reasons:

- High level of non-objective physics energy concept (R. Feynman)
- Low level of non-objective children thinking (J. Piaget)

What is practicable to do?

- Diagnostics of **children's preconception of energy**
- Generating of **preliminary knowledge and understanding** of energy
- Creation of **preliminary skill for simple energy problem solving** in everyday life

Research of energy preconception

Methodology:

- Projective brainstorming concept questionnaire; writing of associated concepts to ENERGY (simple concept mapping); the diagnosis of preconception
- Informant target group: 7, 9, 11 - years old - children – before the teaching of energy
- Number of informants: $50 \times 3 = 150$ children
- The random sample of schools and classes

Research of energy preconception

Analysis of data:

- **Clustering** of associated concepts
- **Frequency** of associated concepts
- **Sequence** of associated concepts

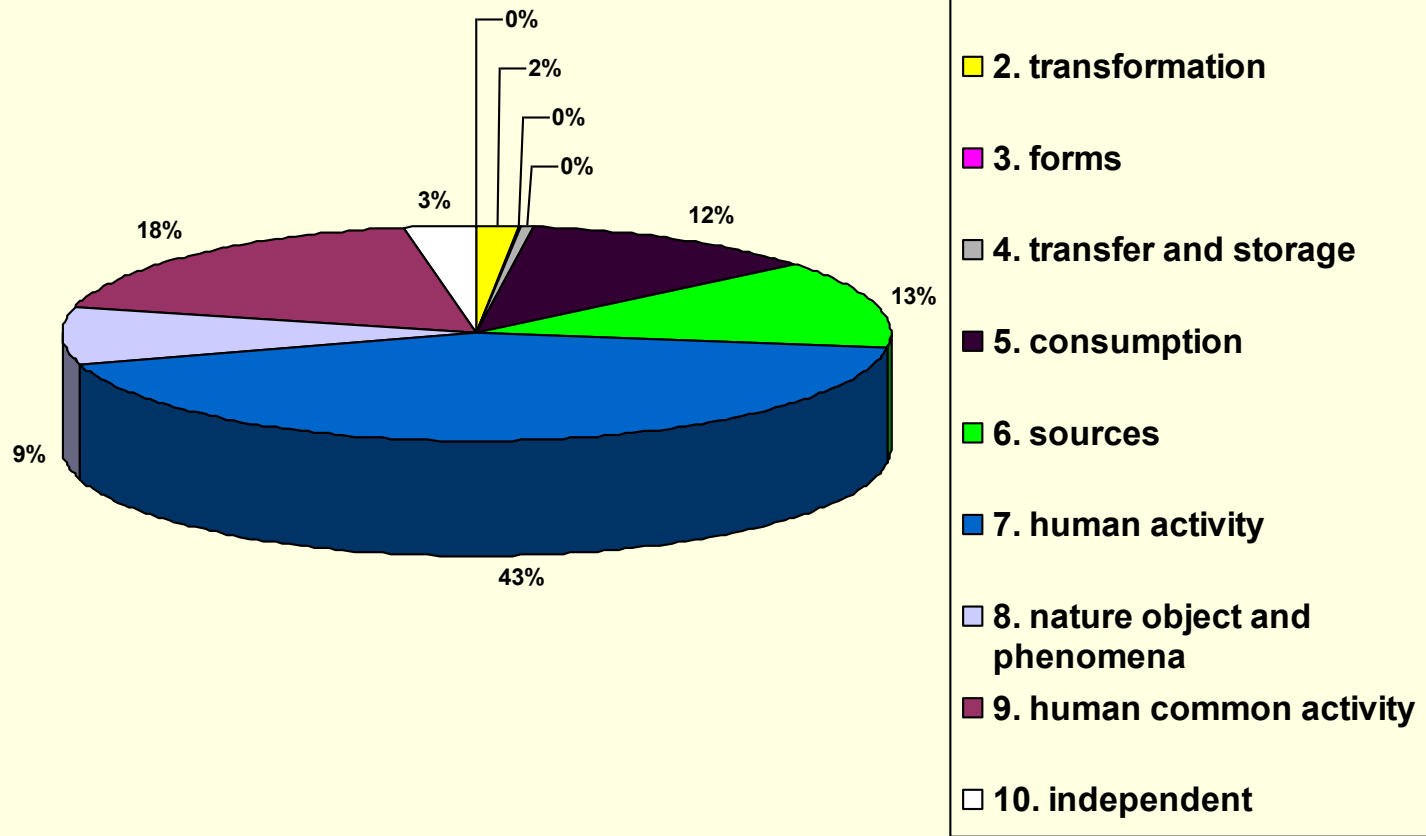
Research of energy preconception

Clustering of concepts:

1. Energy generation (plant)
2. Transformation of energy (work, heat)
3. Forms of energy (mechanical, nuclear)
4. Energy transfer and storage (cable, battery)
5. Energy consumption (car, computer)
6. Sources of energy (Sun, wind, food)
7. Human energy activity (sport)
8. Nature objects and phenomena (blood, cell, lightning)
9. Human common activity (reading, play)
10. Independent objects and phenomena (love)

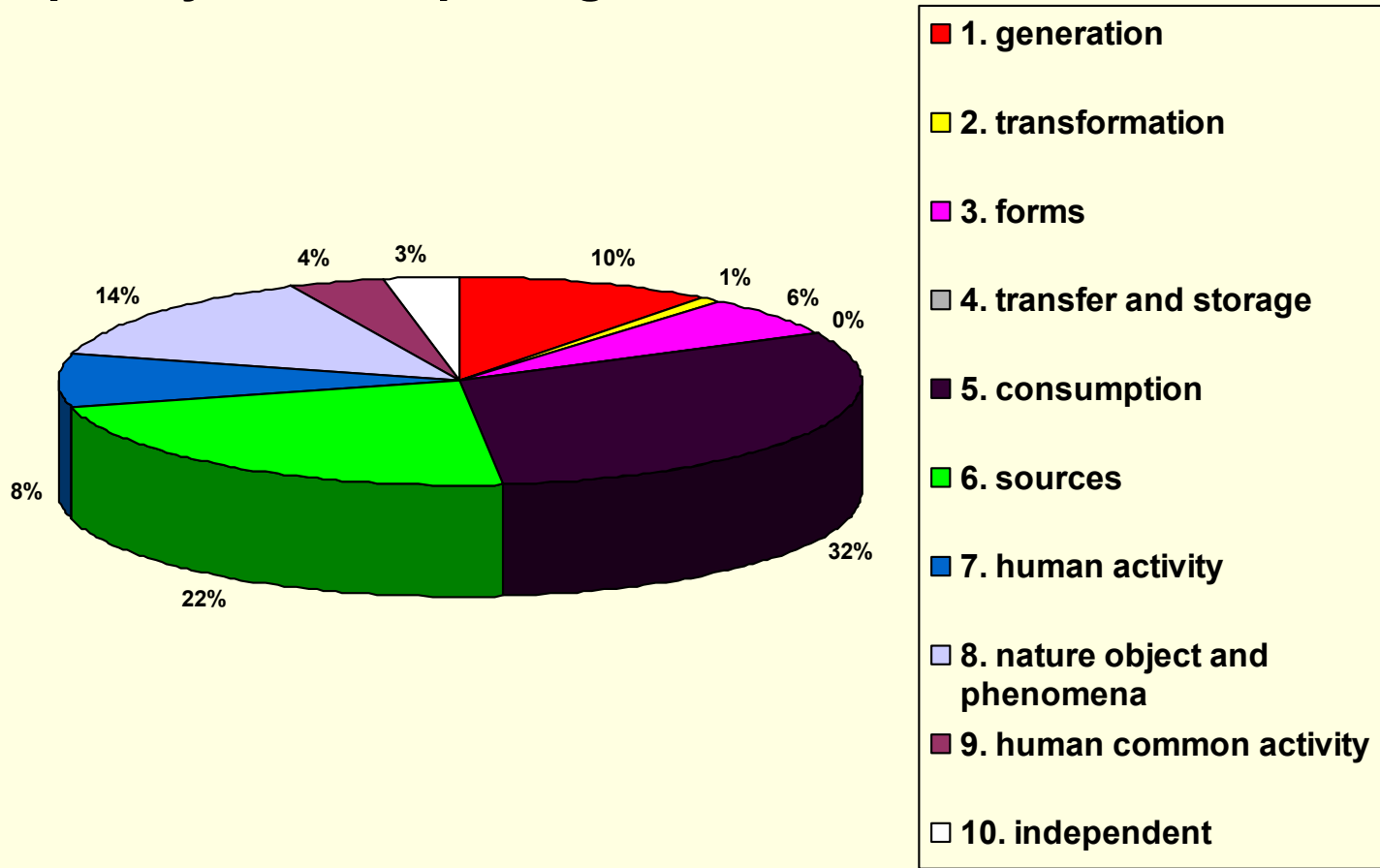
Research of energy preconception

Frequency of concepts: age 7



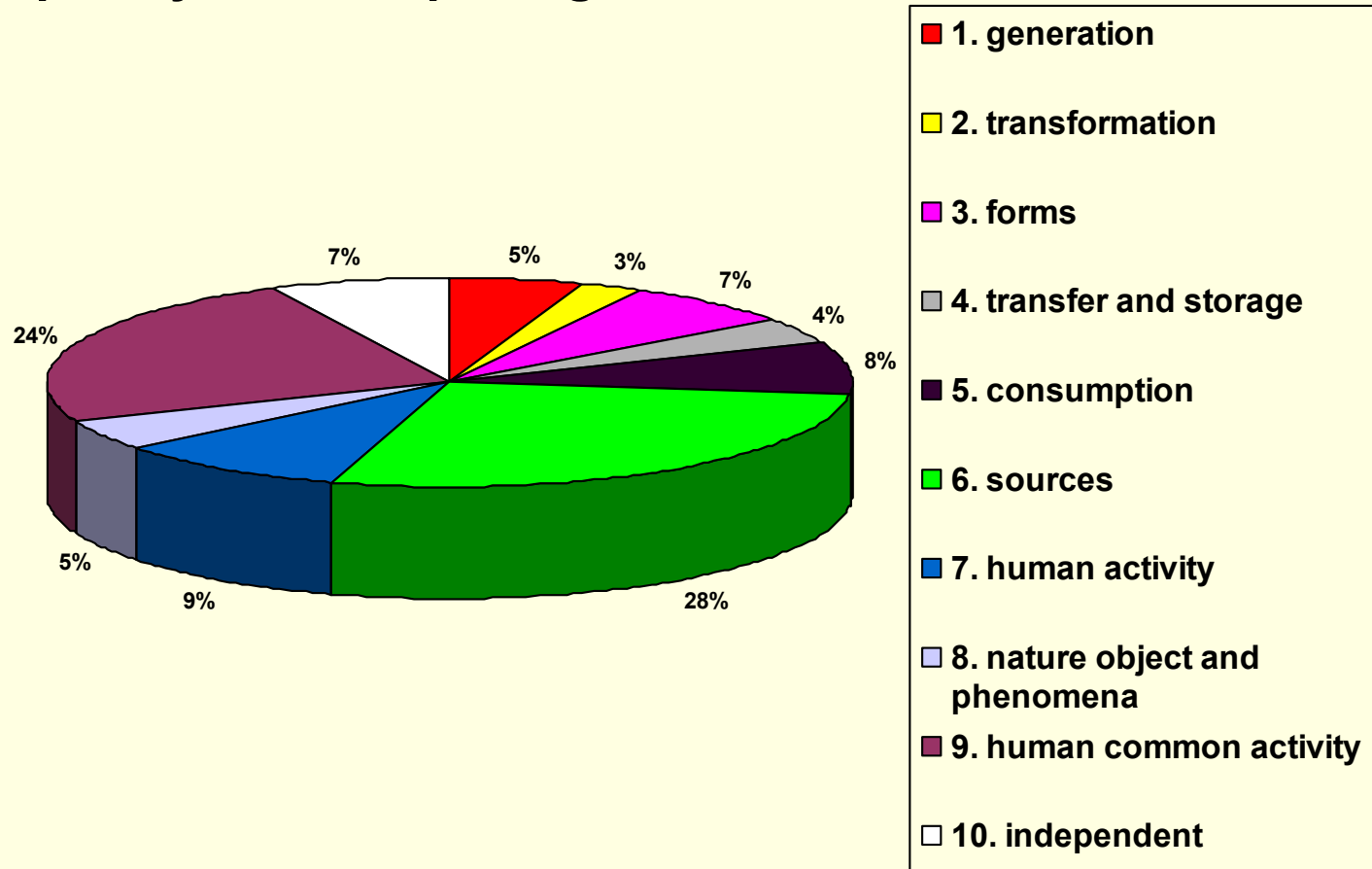
Research of energy preconception

Frequency of concepts: age 9



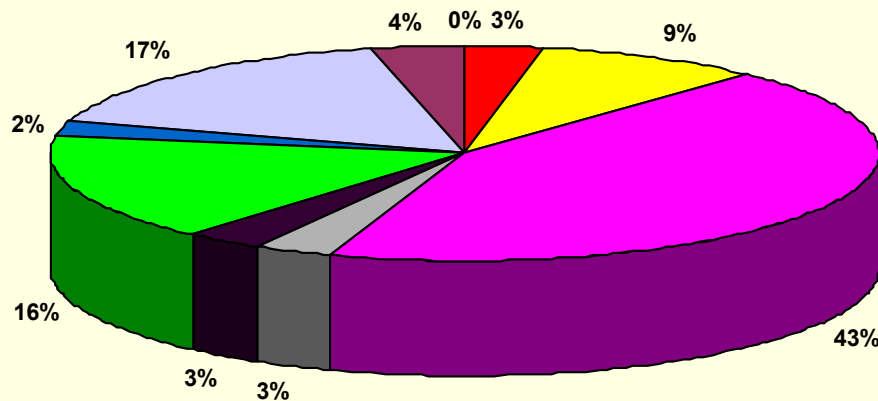
Research of energy preconception

Frequency of concepts: age 11



Research of energy conception

Frequency of concepts: physics
teacher - students - age 23



- 1. generation
- 2. transformation
- 3. forms
- 4. transfer and storage
- 5. consumption
- 6. sources
- 7. human activity
- 8. nature object and phenomena
- 9. human common activity
- 10. independent

Research of energy preconception

Frequency and sequence of associated concepts:

Age 7:

- sport, power, life, food, work

Age 9:

- power plant, food, Sun, electricity, car

Age 11:

- electricity, force, light, human organism, energy drink

Age 23 (physics teacher students):

- nuclear, electric, kinetic and potential energy, heat

Preliminary knowledge, understanding and skill of energy

- **Continuing to good knowledge-preconception:**
 - sources of energy (Sun, water, wind, fuel, gas, biomass, food)
 - consumption of energy (electrical appliances, vehicles)
- **Generating of preliminary qualitative knowledge:**
 - forms of energy (kinetic, potential; electric, magnetic)
 - transformation of energy (work, heat)
- **Creation of preliminary skill for simple energy problem solving in everyday life:**
 - transfer of energy (home distribution of electricity)
 - safe behaviour (home electrical safety)
 - save energy behaviour (home economy, sustainable development)

How is it practicable to do?

The teacher pre-service and in-service training and PCK (pedagogical content knowledge: L. S. Shulman):

1. **Physics** scientific basis of energy concept
2. **Technical** background of school experimenting of energy
3. **Methodical** strategy of teaching energy
4. Reasonable **objectives** of teaching energy

How is it practicable to do?

The cognitive motivation of children:

- **Hands-on and mind-on children activities** in formal and informal science education

Example: The hands-on experiments of kinetic and potential energy.

- The **use of ICT** in formal and informal science education

Example: The video-program of energy.

Experiments with coins

■ Experiment 1

Tools: glass, paper, „heavier“ coin.

Procedure/process:

- cover the glass with the paper,
- put the coin on the paper,
- quickly pull out the paper,
- the coin jumps in the glass.

Explanation: *Inertia* of the coin and small *friction* make the coin to jump to glass.

Experiments with coins

■ Experiment 2

Tools: glass, paper ring, coin.

Procedure/process:

- put the paper ring on the top of the glass,
- put the coin on the top of the ring,
- have the finger in the middle of the ring,
- pull the paper ring to the one side,
- the coin jumps into the glass.

Explanation: *Inertia* of the coin and small *friction* make the coin to jump to glass.

Experiments with coins

■ Experiment 3

Tools: about 5 similar coins, slim ruler or knife.

Procedure/process:

- make a column of the coins and put it on the table,
- quickly push out the lowerest coin with the ruler,
- The rest of the coin are still in the column.

Explanation: Inertia of the coins keeps them in the column.

Experiments with coins

■ Experiment 4

Tools: 5 similar coins.

Procedure/process:

- make a line with the coins (coins have to touch each other),
- firm 3 inner coins to the table with fingers,
- move strongly the first coin to the second one,
- in the opposite side the coin jumps.

Explanation: There is a transfer of dynamics between the coins.

Experiments with coins

■ Experiment 5

Tolls: glass, water, coins.

Procedure/process:

- fill the glass with water (as much as possible),
- carefully throw the coins into the glass with water,
- question: „How many coins you will need for the lipping of water?“

Explanation: Surface tension keeps the water in the glass.

Experiments with coins

■ Experiment 6

Tools: non-transparent pot, coin, water.

Procedure/process:

- put the coin into the pot (in the way we couldn't see it from the side),
- get the water into the pot,
- now we can see the coin from the same place of view.

Explanation: There is a refraction on the surface of water and that is why we can see the coin now (the rays of the light come in the eye).

Experiments with coins

■ Experiment 7

Tools: 2 coins.

Procedure/process:

- Put first coin next to second coin (the space between the coins has to be about 8-10 cm).
- close left eye and concentrate on the coin in the left side,
- Move your head slowly towards the coins,
- When you are about 25–30 cm far from the coins, the second coin will disappear.

Explanation: The rays from the coin that disappeared fall to the blind spot in the eye, where the eye can not see it.

Center of gravity

Tools: glass, cork, match, 2 forks.



Procedure/process:

- put the match into the cork,
- firm 2 forks in the cork (towards to each other),
- put all object on the edge of the glass (like in the picture),
- the object will be in the balance.

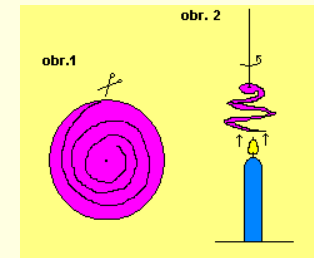
Explanation: The object is supported under the center of gravity and so it is in balance.

Circulation of heat

Tools: candle, paper, scissors, needle, thread.

Procedure/process:

- make a circle from the paper,
- make a hole with the needle in the middle of the circle,
- put the thread (about 20 cm long) into the hole,
- make the spiral from the circle,
- hold the thread with the spiral above the candle.



Explanation: Warm air goes up and starts to roll up the spiral.

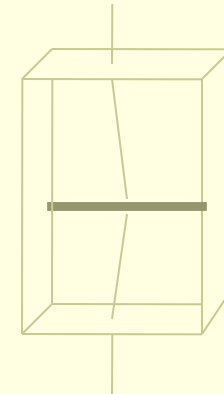
Toys in science education

■ Trained spider

Tools: box of matches, match, thread.

Procedure/process:

- make two holes in the sides of the box,
- put the match in the middle of the box,
- put the thread like in the picture,
- draw the spider on the box.
- hold the ends of the thread (thread is in the vertical location),
- keep the spider up,
- change the tension of the thread and the spider will move and stop.



Explanation: When there is the tension of the thread, friction between the match and the thread stops the spider.

Thank you for your attention.

Josef Trna, Ivana Vaculová, Eva Ochrymčuková

**Masaryk University
Brno, Czech Republic
trna@ped.muni.cz**