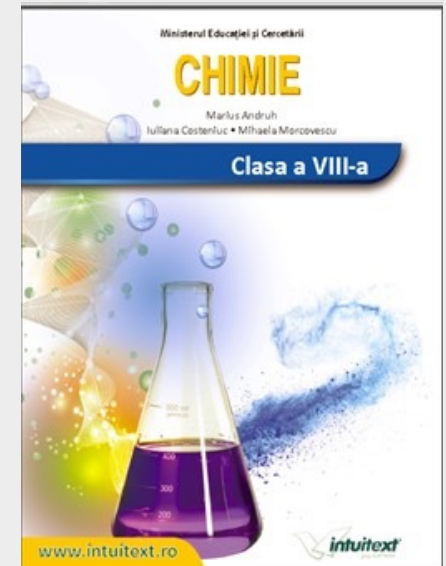


# Teaching and learning science concepts: A corpus of metaphors and analogies used in Romanian secondary education Physics and Chemistry textbooks



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# CommetSci Project

## Communicating science to young generations: Metaphors our children learn by

November 2020-May 2022

(grant awarded to dr. Elena Negrea-Busuioc by the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-TE-2019-1300, within PNCDI III)



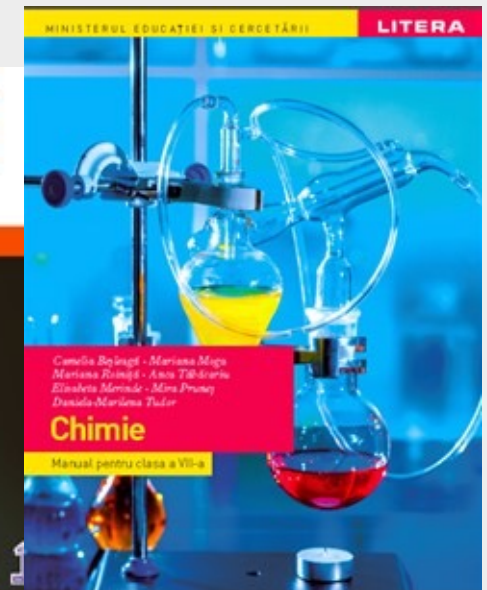
Goal: to examine the **metaphors and analogies used in Romanian science textbooks for lower secondary education** (5th to 8th grade) to explain abstract scientific ideas and to communicate them to students

### Methodology

→ **Content analysis** (we used the Metaphor Identification Procedure (Pragglejaz, 2007) to identify metaphors)

→ **Classroom observations**

→ **Focus groups** (we used the Goal-directed Think Aloud technique (Cameron, 2003))



# STEM education

Scientific literacy is crucial to informed citizenship (Davies, 2014) and school textbooks are instrumental for transmitting knowledge and values to the young generation (Kalmus, 2004).

Science education teaching and learning is important

- to increase young students' interest in science education and careers
- to develop their scientific citizenship

# Explaining abstract concepts

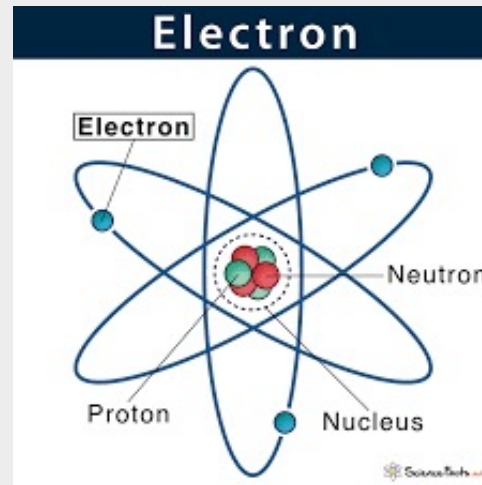
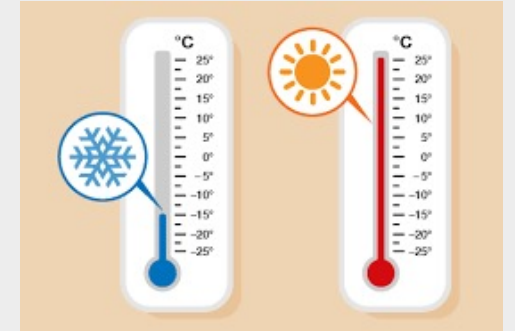
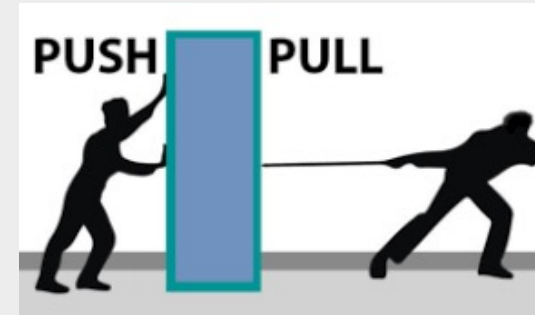
Metaphors and analogies are key components of human cognition; they imply highly sophisticated cognitive processes in which two conceptual domains – a **source** and a **target** - are mapped together so that **knowledge from the source domain is transferred to the target domain**

## Metaphors and analogies in science education

- Generate **new meanings**
- Play an important role in **knowledge acquisition** (Cameron, 2003; Littlemore & Low, 2006; Nacey, 2013)
- **Simplify** complex ideas and communicate them to students (Low, 2005; Cameron, 2003)
- Help us 'see' things from a **different perspective**
- e.g., electricity as water *flowing* through the electric circuit, light as *waves*  
links between molecules as chemical *bonding*, the soil as the *home* of many organisms  
synaptic receptors as *key-lock mechanism*, heart as *pumping* blood into the organism

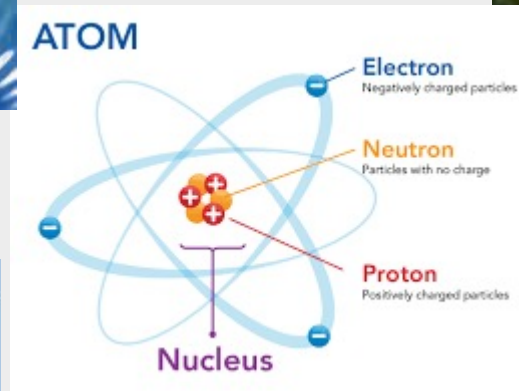
# Corpus Physics's metaphors: The 15 most important target domain:

- ✓ Energy,
- ✓ Bodies,
- ✓ Atom,
- ✓ Force,
- ✓ Pressure,
- ✓ Heat,
- ✓ Temperature,
- ✓ Electrons,
- ✓ Electric charge,
- ✓ Light,
- ✓ Light ray,
- ✓ Beam of light,
- ✓ Universe,
- ✓ Sound,
- ✓ Mechanical wave





# Corpus Chemistry's metaphors: The 8 most important target domain:



- ✓ Atom,
- ✓ An atom's electron shell
- ✓ Bodies,
- ✓ Substances,
- ✓ Soil,
- ✓ Water,
- ✓ Air,
- ✓ Pollution

# Some sources domain for the target domain (Physics textbooks):

## ➤ **The energy:**

- economic product: "produce",
- object: "stored",
- food: "preserved",
- human being: "released",
- vehicle: "coming",
- communication: "transmitted",
- goods: "supplied",
- military domain: "is released".

## ➤ **The light rays:**

- road: "very narrow",
- object: "bundle",
- human being: "suffering",
- vehicle: "go".

## ➤ **The universe:**

- book: "big book",
- human being: "born",
- container: "the whole".

# Some sources domain for the target domain (Chemistry textbooks):

## ➤ **The atom:**

- biology: "species",
- container: "concentrate",
- human being: "is responsible",
- food: "preservation of the number of",
- universe: "born of stars",
- liquid: "wave",
- vehicle: "they have arrived".

## ➤ **The water:**

- human being: "suffered",
- container: "shell"
- Transport: "circulate",
- politics: "adhere to",
- insurance: "insure".

## ➤ **The air:**

- material: "gas coating",
- human being: "protects",
- container: "protective layer",
- economic: "supplier".



# Metaphors and analogies in Physics and Chemistry textbooks: implications for understanding science concepts

Metaphors and analogies found in the analyzed textbooks are similar to the **widespread, conventionalized definitions** of core Physics and Chemistry concepts

- e.g., light as a wave, electricity as water flowing, electrons as vehicles, energy as an object, heat as an object
- e.g., the atom structure as the Solar System, pollution as an attack, atmosphere as a greenhouse

However, we identified some novel metaphorical associations that **may, to some degree, undermine the understanding and learning of abstract scientific concepts**

- e.g., atoms as chopped pieces of wood or as letters in a word (Physics, 6<sup>th</sup> grade)
- e.g., chemical substances as transportation vehicles (Chemistry, 7<sup>th</sup> grade)

# Conclusions

Metaphors and analogies permeate science education by **contributing to as well as inhibiting learning**.

→e.g., the atoms as pieces of woods metaphor is supposed to enable children make connection between what they already know (existing knowledge) about chopping wood and the unfamiliar concept of atom (new knowledge); however, this direct metaphor may not easily afford an analogy with a more tangible concept in the mind of children aged 10 or 11

While many metaphors in the corpus seem to help **simplify scientific concepts**, there are some associations entailed by metaphors that **can be obfuscating as much as they can be illuminating for young learners**.

*Thank you!*

Comments and suggestions are welcome!

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