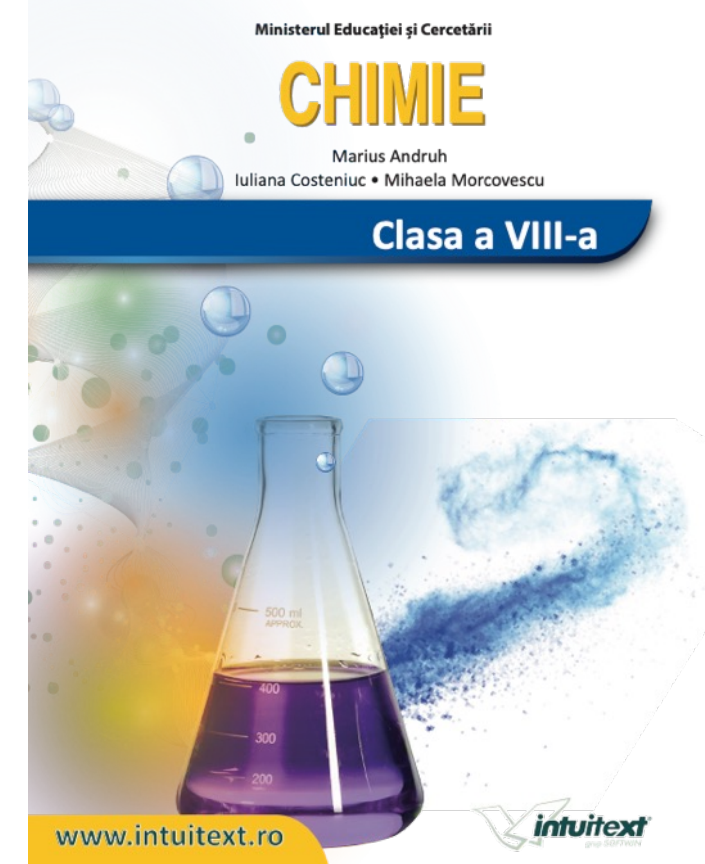




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Communicating Science in a Networked Society: A Corpus-based Approach to Verbal and Visual Metaphors in Romanian Textbooks

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Communicating science to young generations: Metaphors our children learn by

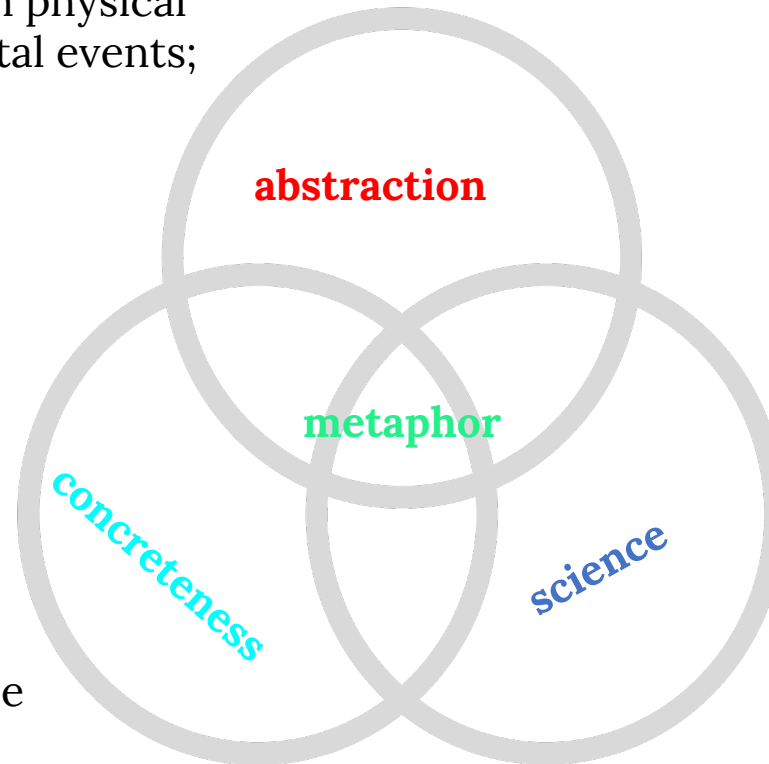
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Metaphors & abstract knowledge

- ● ▶ **Abstraction > abstract concepts** (Barsalou, 2003): concepts detached from physical entities; associated with mental events; properties and relations



- ● ▶ **Concreteness**: the degree to which a referent in the real world is associated with a concept that can be accessed via sensory experience (Bolognesi et al., 2020); perceptibility; image-arousing value of items (Paivio, 1986); visualization

- ● ▶ **Metaphor**: allows us to map concrete knowledge onto abstract concepts (Lakoff & Johnson, 1980; Gibbs, 1994); embodiment; metaphor comprehension relies on sensorimotor simulation (Jamrozik et al, 2016)

Methodology

Content analysis

- MIP(VU)
- 16 textbooks: physics (6), chemistry (5), biology (5); lower secondary education
- pre-defined target domains ~ scientific topics taught
- Visual metaphors

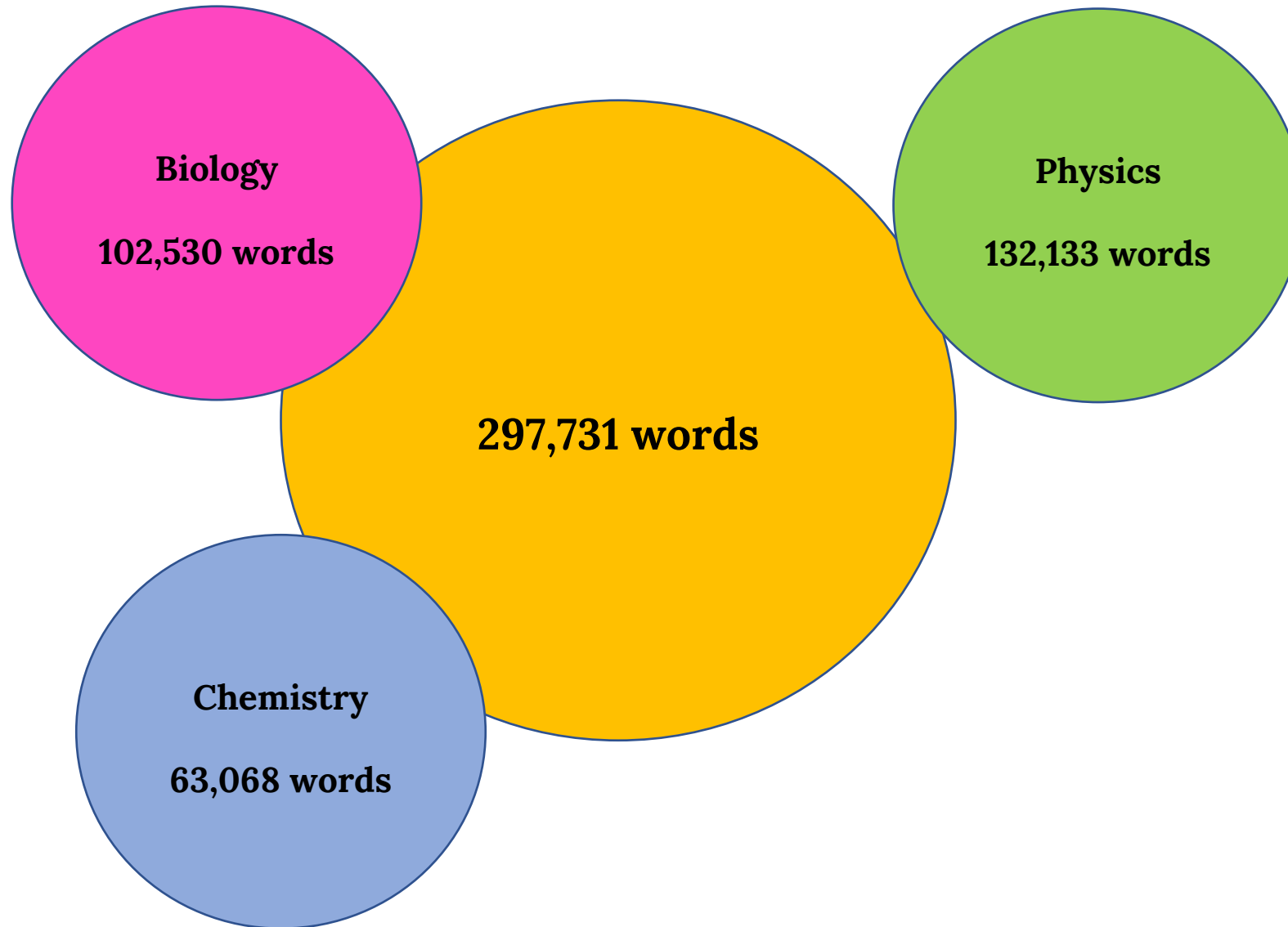
Classroom observation

- Observation protocol
- 3 observations; biology (2) and chemistry (1); online
- 1 school from Bucharest and 2 schools from Slobozia (Ialomita county)

Dyads

- GITA (Goal-Directed Interactive Think Aloud) protocol
- text & video-based thinking-and-talking
- fragments from textbooks; heart (biology), electricity (physics) and electron configuration (chemistry)
- 14 dyads + 1 triad; biology (9), chemistry (2), physics (4); online
- Students enrolled in secondary education; grade 6 (10); grade 7 (12), grade 8 (5)
- 14 male & 15 female students
- residence: Bucharest, Valsui (VS county), Slobozia (IL county), Caracal (OT county), Fierbinti (IL county)

Corpora



Target domains

	Grade 6		Grade 7		Grade 8	
	Target domains	#M	Target domains	#M	Target domains	#M
Physics	physical body	37	force	33	electricity	110
	light	28	energy	26	light	76
	electricity	18	pressure	10	heat	67
Chemistry			atom	20	atom	4
			air	5	energy	3
			water	5	substance	3
Biology	energy	22	nervous system	10		
	heart	20	neuron	8		
	cell	5	energy	7		

Conventional metaphors

Physics

Electric circuit as the road traveled by electric charges
Flowing of electrons in the circuit
Conductors allow electricity to flow

Chemistry

Atoms as objects
Connections between atoms as bonding
Atmosphere as a greenhouse

Biology

Synaptic receptor as key-lock mechanism
Heart as a pump
Central nervous system as a computer

Novel metaphors

Physics

Atoms as chopped pieces of wood

Chemistry

Chemical substances as transportation vehicles
Electron shells as field track lanes

Biology

Genital organs as entry gates
Plants as living chemical plants

Simplification and communication of abstract concepts in science education

Simplification

- ▶ Metaphors simplify abstract concept by making them easier to understand via correspondence with other concepts which are conceptually simpler

Understanding

- ▶ Metaphors comprehension depends on the ease with which people process it and on the ease with which metaphors evoke a mental image

Communication

- ▶ Metaphors facilitate comm by enabling overt comparisons between abstract ideas and simpler, more familiar concepts

To describe the electron configuration in an atom, we could draw an analogy with a track and field event (running) which takes place on a circular track. Athletes have the tendency to occupy the inside lane of the track because the distance they must run is shorter and therefore the amount of energy they consume is smaller. As the inside lane is occupied, the other athletes must occupy lanes that are more far away from the centre and, therefore, a higher amount of energy is required to run the distance. Only a certain number of athletes are allowed on each lane. Atomic structure contains electron shells similar to lanes on a field track. In an atom, there can be n shells numbered with digits 1, 2, 3, 4, 5, 6, 7, or with letters K, L, M, N, O, P, Q.

(Chemistry, grade 7, Intuitext, pag. 57)

TARGET

Electrons
Electron configuration
Electron shells
Orbiting

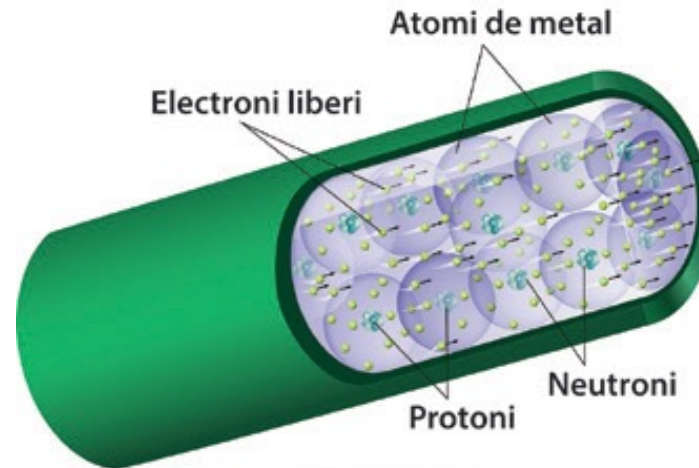
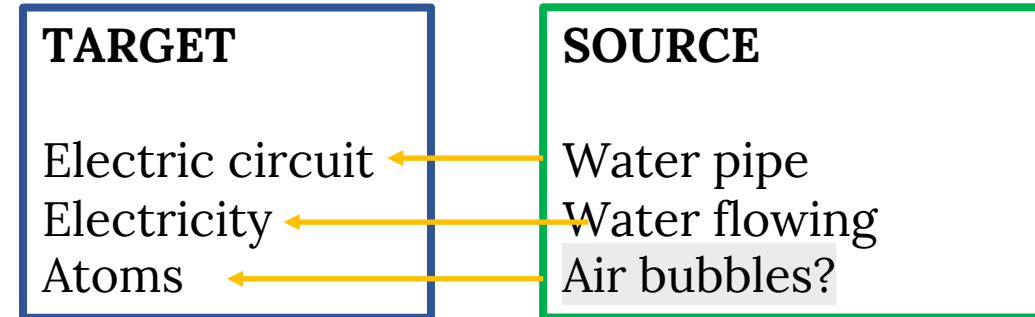
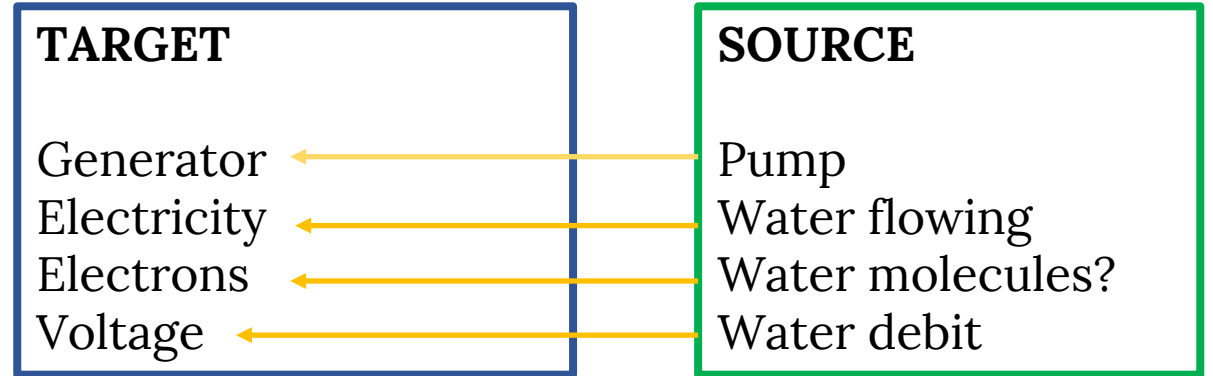
SOURCE

Athletes
Track field
Lanes
Running



The generator is like a pump that raises the water into a high tank from where it will flow freely – like the “flowing” of electrons in the circuit.

(Physics, grade 8, Litera, p. 57)



To conclude

- ▶ Physics textbooks were more populated with metaphors compared to biology and chemistry textbooks
- ▶ High frequency of conventionalized (discipline-specific) metaphors used to explain abstract concepts from physics, biology and chemistry
- ▶ Integration of visual imagery in science education, including textbooks, to facilitate students' understanding of complex scientific phenomena
- ▶ **However**, not all metaphors and analogies are effective in science education (e.g., the visual rendition of the mapping between water flowing in a pipe and current flowing in a circuit, since the graphical depiction of atoms as bubbles could evoke knowledge about the circulation of water in pipes that may be incompatible with the target)