

EXAMPLES OF SCIENCE MISCONCEPTIONS (“ALTERNATIVE CONCEPTIONS”) AND TEACHING MODELS FOR DEALING WITH/AVOIDING THEM

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TEACHING MISCONCEPTIONS ACCIDENTALLY: TEACHING BY ANALOGY CAN INTRODUCE MISCONCEPTIONS IF THE LIMITATIONS OF THE ANALOGY ARE NOT EXAMINED

Some Examples from Teaching Plate-Tectonics (Nottis, 1999, pp. 450-451)

Analogy	Limitation #1	Limitation #2	Limitation #3
Earth is like a peach	Smooth skin is unlike actual top layer broken into pieces	Peach “meat” does not have fluidity (plasticity) of the mantle	Solid peach seed differs from Earth’s liquid core with solid inner core.
Earth’s interior is like a hard-boiled egg	Eggshell pieces have same density, whereas oceanic and continental lithospheric plates differ in density.	Eggshell pieces do not move, whereas lithospheric plates move.	Egg has one inner section (yolk), whereas Earth has solid inner core and liquid outer core.
Tectonic plates move like potato chips riding on honey	Dragging chips along illustrates only “mantle entrainment,” not fresh material rising at mid-oceanic ridges and plates descending at subduction zones.		

EFFECTIVELY USING ANALOGIES IN SCIENCE TEACHING, USING THE HARD-BOILED EGG EXAMPLE (Nottis, 1999, p. 452)

1. **Introduce the “target” concepts (the concepts to be studied).** Example: the Earth has a layered interior of different thicknesses.
2. **Recall the “analog” concept (the familiar concept (from which an analogy to the target concept(s) can be drawn.** Example: Hard-boiled eggs are composed of different layers.
3. **Identify the pertinent features of the concepts.** Example: Both the Earth and the egg have a layered interior. The eggshell is very thin compared to the rest of the egg, and the Earth’s crust is very thin compared to the rest of the Earth. The earth’s outer layer is broken into pieces.

4. **Map similar features** (say, with visual tables and charts).
5. **Note where the analogy fails.** Example: Tectonic plates move; eggshell pieces do not. The Earth has a two-layered core; the egg has one inner section (yolk). One of the Earth's cores is liquid, the other solid; the yolk of a boiled egg is solid.
6. **Draw conclusions about the new concepts.**

POSSIBLE PROBLEMS WITH A STATIC MODEL, LIKE A HARD-BOILED EGG (Nottis, 1999, p. 452)

- Students can view structural components, such as the layers of the Earth, as distinct from the processes taking place.
- This can happen especially if students focus on surface features, rather than relational features.

IMPROVED ANALOGICAL TEACHING (Nottis, 1999, p. 452)

- Multiple Analogies: Use several different analogies to teach the same or related concepts.
- “Extended Analogies”: Use analogies that focus on an entire system, rather than on individual segments of that system.

SOME MISCONCEPTIONS IN PHYSICAL GEOGRAPHY (Nelson, Aron, & Francek, date?)

These misconceptions were “drawn from a half century of teaching undergraduate physical geography at various locations in the United States,” p. 1)

Type	Misconception	Correct Conception
Locational	1. Africa is a southern hemisphere continent similar in latitudinal range to South America. 2. Much of Europe is as southerly as the U.S.	1. Africa extends northward to about the same latitude as Norfolk, Virginia, with about 2/3 of its area positioned north of the equator. 2. The Scandinavian countries have a latitudinal range similar to Alaska. Most of mainland Europe lies to the east of Canada. Venice, Italy has a slightly more northerly latitude than Minneapolis, Minnesota.
Oceanographic	The Atlantic, Arctic, and Pacific Oceans are about the same size. [Due probably to map divisions and distortions.]	The Pacific Ocean is nearly twice as large as the Atlantic. The Arctic Ocean is about 3% of the world's ocean area.
Sea Level	The ocean surface has no actual relief of its own, except for short-lived changes like waves, tides,	The ocean surface possesses “hills” and “depressions” with a maximum variability of about 8 feet, due to surface currents that produce water convergence and

	surges, etc.	divergence.
Lightning	Lightning does not strike the same place twice.	Since lightning tends to frequently strike the highest points within a given area, such locations are likely to be struck repeatedly.

“CALORIC,” AN 18th CENTURY CONCEPT SIMILAR TO A CURRENT MISCONCEPTION (Halliday & Resnick, 1962, pp. 466-467)

- True: When two systems at different temperatures are placed together, the final temperature reached by both systems is somewhat between the two starting temperatures.
- Caloric: Up to the beginning of the 19th century, such phenomena were explained by postulating the existence of a substance, “caloric,” in every body.
- It was believed that a body at high temperature contained much caloric, and one at low temperature contained just a little caloric.
- What happens to caloric: When the two bodies were put together, the body rich in caloric lost some to the other until both bodies reached the same temperature.
- Caloric described some processes well: Actually, the caloric theory was able to describe some processes, such as heat conduction or the mixing of substances in a calorimeter, in a satisfactory way.
- Demise of the caloric theory: The concept of heat as a substance, whose total amount remained constant, eventually could not stand the test of experiment.
- Even today people often describe many common temperature changes as the transfer of “something” from one body at a higher temperature to one at the lower temperature, and this “something” they call heat.

SOME COMMON MISCONCEPTIONS OF HEAT AND TEMPERATURE (Sozibilir, 2003)

Misconception	Students’ Age (years old)	Reference
There are two types of heat, cold heat and hot heat.	6-13	Erickson (1979, 1980, 1985)
Heat is a material substance, like air or steam.	6-13	Same as above
The temperature of any object is related to its size.	6-13	Same as above
Heat is hot, but temperature can be cold or hot.	12	Tiberghien (1985)
There is no difference between heat and temperature.	12	Same as above
Temperature will change during melting or boiling.	12	Same as above

REFERENCES

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