Professional Development to Improve Spatial Thinking of Earth Science Teachers & Students

Representational Correspondence II:

Profile

Kim Kastens
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Lamont-Doherty Earth Observatory
Learning Goals

• Students will sharpen and apply their ability to perceive meaningful information in representations of the Earth System (drawings, photographs, maps, diagrams, profiles, block diagrams, etc.)

• Students will be able to identify and describe similarities and differences in subtly different representations of Earth phenomena.

• Students will develop language for discourse about spatial phenomena.

• Students will be able to figure out and articulate where was the vantage point for an Earth Science representation.

• Students will be able to combine and integrate multiple types of information from two or more representations, to make inferences about Earth structures and processes.
Three challenges

• Challenge #1: Distinguish commonalities and differences among similar representations (same content, same vantage point)

• Challenge #2: Combine information from two spatial representations, when both are from the same perspective

• Challenge #3: Combine information from two spatial representations which are from different perspectives
Challenge #1: Distinguish commonalities and differences among similar representations.
Challenge #2: Combine information from two spatial representations... when both are from the same perspective.

Identify the New York State landscape region that has the greatest average yearly amount of precipitation.
Challenge #3: Combine information from two spatial representations which are from different perspectives.

Between which two lithospheric plates could this boundary be located?
The maps below labeled A, B, and C show three different stream drainage patterns.

<table>
<thead>
<tr>
<th>What the images have in common:</th>
<th>How the images are different</th>
</tr>
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<tbody>
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<td></td>
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A

B

C
Same Vantage Point/Same Content: Similarities & Differences

• Moon phases: same and different. Full moon versus lunar eclipse. They could tell the difference even before instruction on eclipse.
• They think the new moon is because the earth blocks the sun.
Spatial language:

**Direction** (e.g. N/S/E/W, above/below, upstream/downstream, vertical/horizontal)

**Configuration** (e.g. above/below, adjacent to/ distant from, concentric/radial)

**Size** (e.g. larger/smaller; volume/area/length)

**Shape** (e.g. solid/hollow, angular/rounded, straight/curved)

**Motion** (e.g. trajectory, towards/away from)

**Representational Conventions** (e.g. stippled, shaded, arrow, caption)
The importance of spatial language

- Experimenters recorded natural language use between 52 parent and child pairs every 3 months from age 14 mo to 46 mo.

- They tallied use of spatial terms (e.g. “circle”, “big”, “corner”).

- At 54 mo, they tested children’s spatial ability.

- If parents used more spatial language, kids used more spatial language.

- If kids used more spatial language, kids did better on spatial tasks.

If these two pieces were put together...

... which of these four shapes could they make?

Three challenges

• Challenge #1: Distinguish commonalities and differences among similar representations (same content, same vantage point)

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• Challenge #2: Combine information from two spatial representations, when both are from the same perspective but have different content

• Challenge #3: Combine information from two spatial representations which are from different perspectives
Three challenges

• Challenge #1: Distinguish commonalities and differences among similar representations (same content, same vantage point)

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• Challenge #3: Combine information from two spatial representations which are from different perspectives
So why can’t scientists just make up their minds and use the same kind of representation all the time?  

Because multiple 2-D views from different directions give you a more complete view of the 3-D object.
Drawing to Learn in Science

Shaaron Ainsworth, Vaughan Prain, Russell Tytler

Should science learners be challenged to draw more? Certainly making visualizations is integral to scientific thinking. Scientists do not use words only but rely on diagrams, graphs, videos, photographs, and other images to make discoveries, explain findings, and excite public interest. From the notebooks of Faraday and Maxwell (1) to current professional practices of chemists (2), scientists imagine new relations, test ideas, and elaborate knowledge through visual representations (3–5).

However, in the science classroom, learners mainly focus on interpreting others’ visualizations; when drawing does occur, it is rare that learners are systematically engaged in creating them. Revealing understanding. Drawings by two 11-year-olds (left and right) of an evaporating handprint show representational choices that guide and communicate individual understandings.
What is this a drawing of?

Four elephants inspecting a grapefruit…

…. as seen from above!

What is this a drawing of?

A ship arriving too late to rescue a witch…

…. as seen from the side!

Strategy 1: What is the point of view (vantage point)?

Map view: Looking vertically down from above

Profile view: Looking horizontally from the south towards the north

In which cross section do the arrows best show the convection occurring within the asthenosphere beneath line XY?
Strategy 2: Color highlight the corresondences.

Mentally move and rotate one of the images until the colored lines are together.
40 The diagram below shows how Earth is illuminated [lighted] by the Sun as viewed from above the North Pole.

In which orbital position would Earth be illuminated as shown?

(1) A  (3) C
(2) B  (4) D
View looking obliquely at the Earth’s orbit from outer space, from a vantage point that is outside of Earth’s orbit and on the northern hemisphere side of the plane of the ecliptic.

View looking vertically down on Earth from above the North Pole.
Critique this representation:
Take home messages

• Talk about spatialness, using spatial language.
• Have students talk about spatialness.
• Practice detecting and describing spatial relations, including similarities and differences.
• Drawing is good.
• Things look different from different directions. Views from multiple directions convey the full 3-D shape and configuration.
• Practice discerning and describing vantage point.
• Have students critique representations.