Spatial Education across the College Curriculum: A Psychologist’s Perspective

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Outline
Spatial content
Developmental insights
Interdisciplinary partnerships
What next?

Spatial content
what should be taught?
collection of mental spatial skills?
useful spatial technologies?
conceptual systems?

Concepts of Space (Piaget)
• Topological
• Projective
• Euclidean

Representational Geometries (Hagen)
• Orthogonal
• Affine
• Projective

Center for Spatial Studies UCSB
TeachSpatial
http://www.teachspatial.org/}

Karl Grossner, Ed. Of TeachSpatial
**Systematic approach**

surfeit of choices

is agreement possible?

at minimum: make one explicit

ideally: articulation among several

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**Systematic approach**

generative

-- applications to endless substantive fields & to emerging technologies

meta-cognitive

-- foster habits of mind

-- facilitate transfer

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**Summary**

Identify (articulate) systematic spatial structures to organize spatial instruction & foster students’ understanding of those structures.

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**Outline**

Spatial content

Developmental insights

Identify challenges
Water Level Performance by Sex

Liben & Golbeck (1986)
Summary

Look to developmental theory & research to identify target spatial challenges.

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Understanding the Geological Concept of Strike

• Strike: the line at the intersection between the horizontal plane and the plane of a rock surface, recorded on a map by a line.

Liben, Kastens, & Christensen (2011) Cognition & Instruction

Key Question

• Do adults struggle to understand strike & does their understanding vary with their spatial skills?

Liben, Kastens, & Christensen (2011) Cognition & Instruction

The Dynamic Earth: An Introduction to Physical Geology.
Individual Differences in Spatial Skills

WLT given to 655 students
Recruited high, medium, & low (M/F)

Artificial Outcrop

A Lesson on Strike & Dip

Observe Outcrop, Record Strike on Map

Strike

High WLG  Medium WLG  Low WLG

Correct
Our illustrative geologist wakes up at sunrise in the desert. Over breakfast, she (1) studies her topographic map to (2) plan a traverse for the day. She intends to walk (3) along the road, (4) up a creek bed, and (5) onto the (6) top of a (7) mesa ... and hopes that she’ll be able to get (8) down a (9) different way than she came up to (10) make a loop back to camp.

At first, her (11) route takes her past (12) flat-lying sedimentary rocks that she (13) determines are sandstone. As she (14) continues toward the (15) mesa, she notices that the (16) orientation of the (17) sedimentary layers (18) begins to steepen until they are (19) nearly vertical. She makes (20) measurements of (21) these changing bedding orientations (22) using a compass and (23) records their locations on the map. After (24) walking past the (25) vertical sedimentary layers, she finds herself in an area with a dark, (26) massive, (27) crystalline rock with white elongate minerals. She (28) deviates from her planned traverse to walk (29) along the contact (30) between the (31) igneous and sedimentary rocks to (32) record its location on her map.

After her field season, she continues to analyze and interpret her data. She makes two perpendicular cross-sections through the igneous intrusion to get a sense of the three-dimensional structure (Fig. 3). She plots the orientations of the structural data on stereographic projections to look for patterns in the lineation data (Fig. 4). Based on the lineation orientations, she infers that the Black Mesa intrusion was fed by magma from below (at the spot on the map where lineations are steepest) and that this magma then intruded as horizontal sheets between sedimentary layers. Comparing this intrusion with other regional intrusions, she and her colleagues develop a model for the geologic history of this intrusion describing how the intrusion grew taller by the intrusion of successive sheets of magma (Fig. 5).
Summary
Collaboration between learning scientists and STEM content experts is reciprocally useful…
   expands knowledge, skills, habits of mind (e.g., figures)

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Future directions
Design, implement, & evaluate interventions at general (overarching spatial structure) and precise (specific STEM content) levels simultaneously.
   --domain-general curriculum? (spatial arts || language arts?)
   --link to STEM-specific courses (|| writing across curriculum)

Future directions
Attend to affective (motivational) as well as cognitive factors.

Future directions
Address the developmental pipeline.
   --capitalize on developmental insights
   --coordinate w/ design of early interventions
   --consider proficiency tests (exit HS, enter college?)

Future directions
Build new professional of “spatial curriculum specialists” to work collaboratively with STEM educators to identify & respond to learner needs for specific content.
   --Maps, Tools for Adventure
   --Geo- and Cognitive-Science Synthesis
   --Discovery Space: Astronomy activities