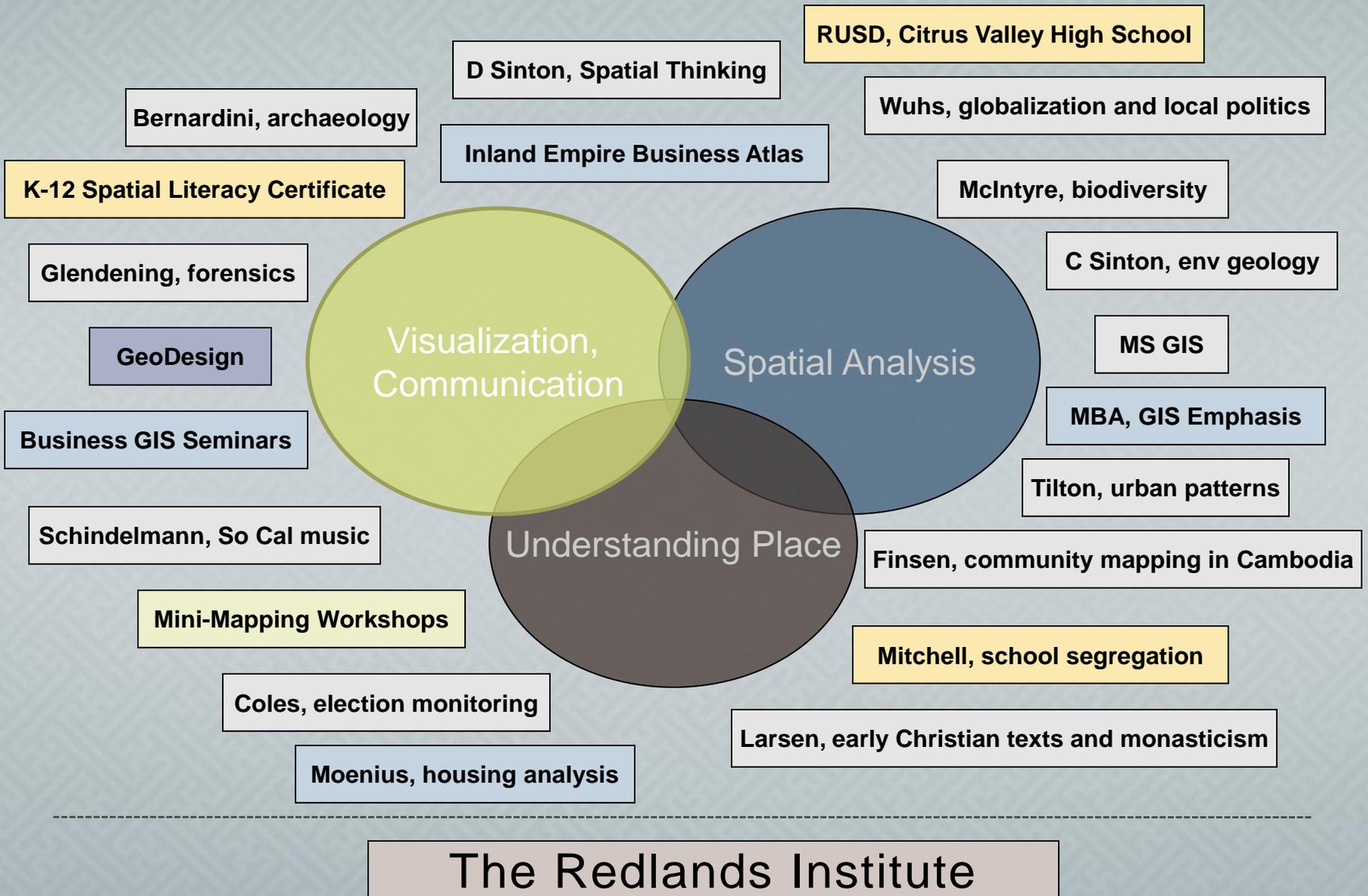


# How Can We Reap the Greatest Educational Benefits from GIS?

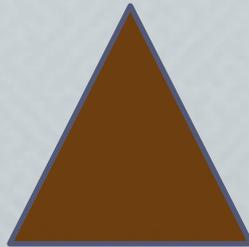
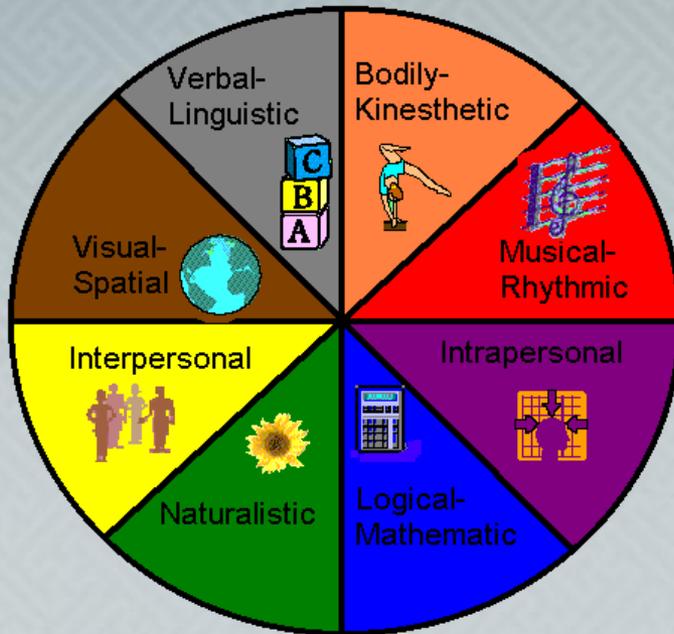
National Summit for GIS and K-12 Education  
James Madison University

Diana Stuart Sinton  
Director of Spatial Curriculum & Research  
University of Redlands



- 1) Brief overview of some spatial thinking ideas
- 2) Ways to address spatial thinking with students
- 3) Making connections with both **GIS** and **learning** overall

# Howard Gardner, Multiple Intelligences



Accurate mental visualization; Mental transformation of images.

The capacity to form mental imagery of the world—the large world of the aviator or navigator, or the more local world of the chess player or the surgeon—and to manipulate those mental images.



**Spatial Intelligence and Learning Center**  
*NSF Science of Learning Center*



Home

Research

Projects

People

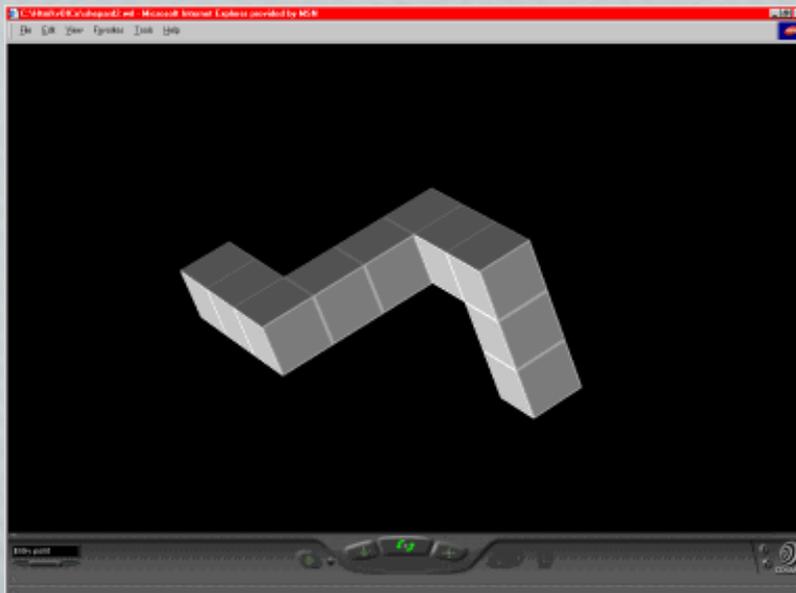
Publications

Resources

Bibliography

Wiki

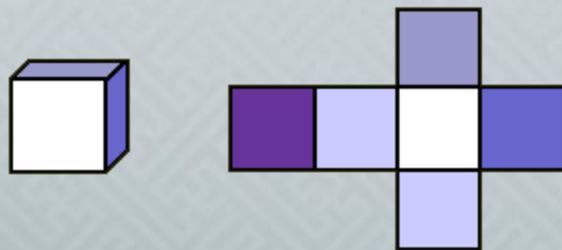
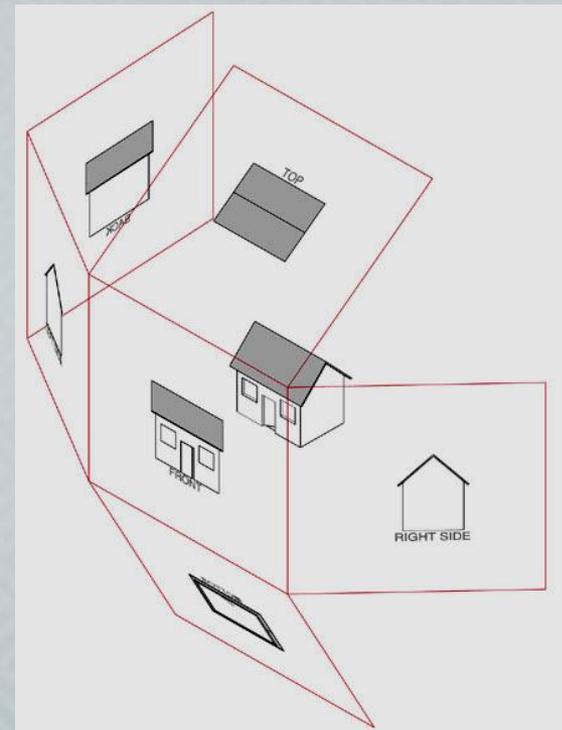
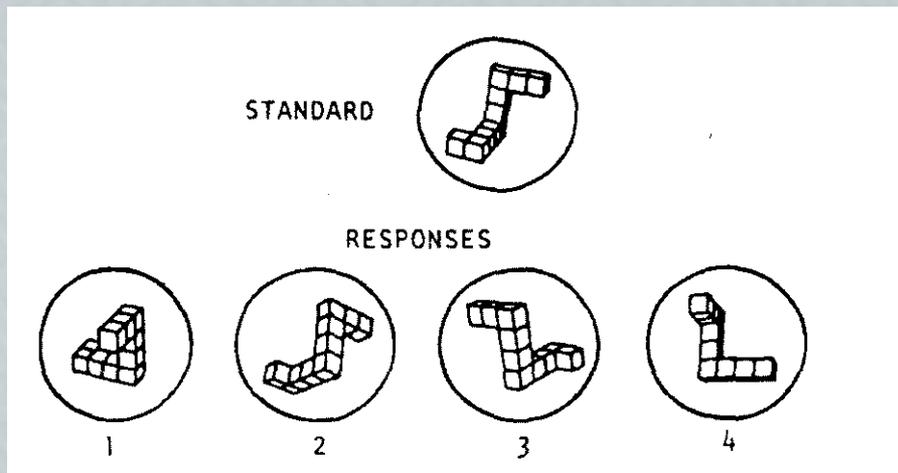
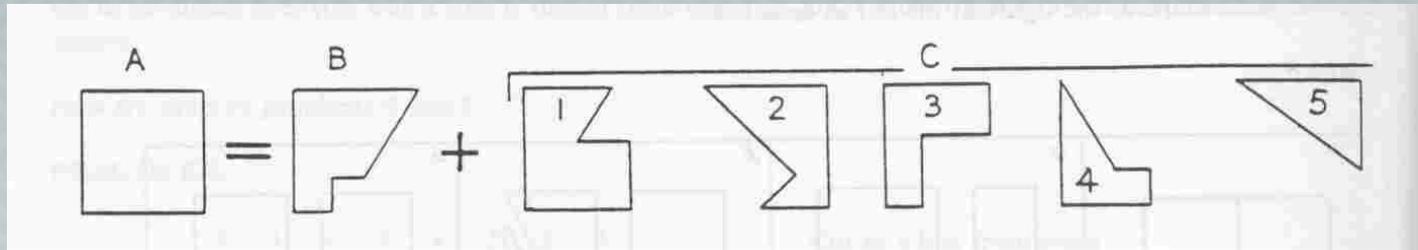
Archives

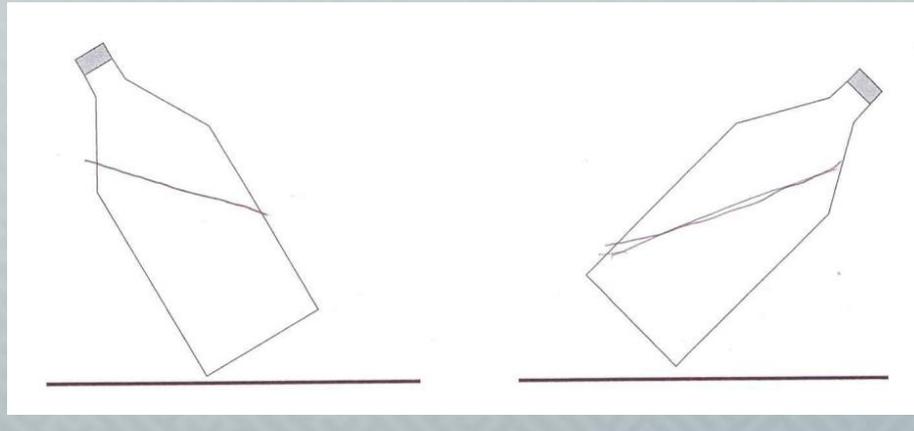
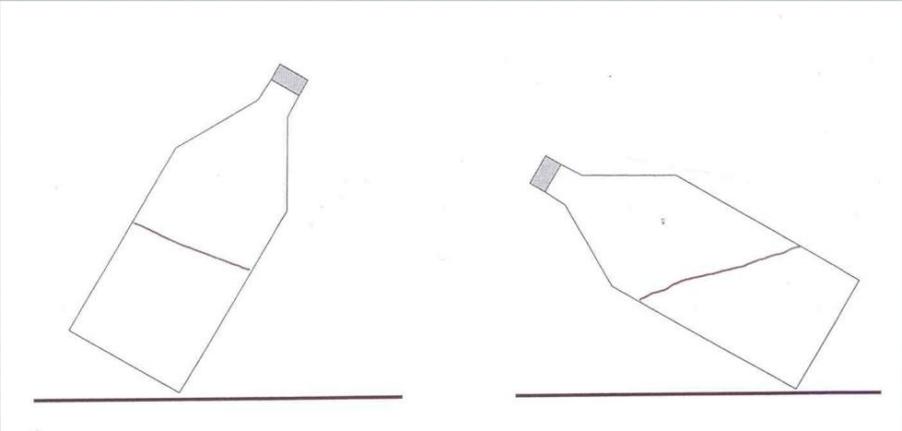
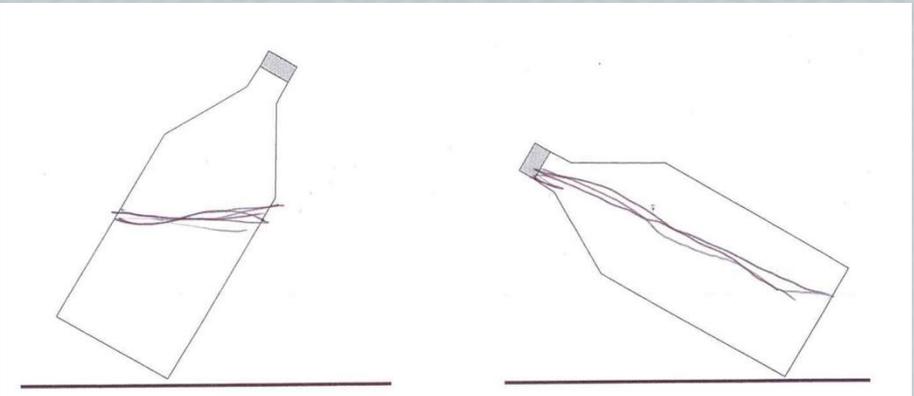
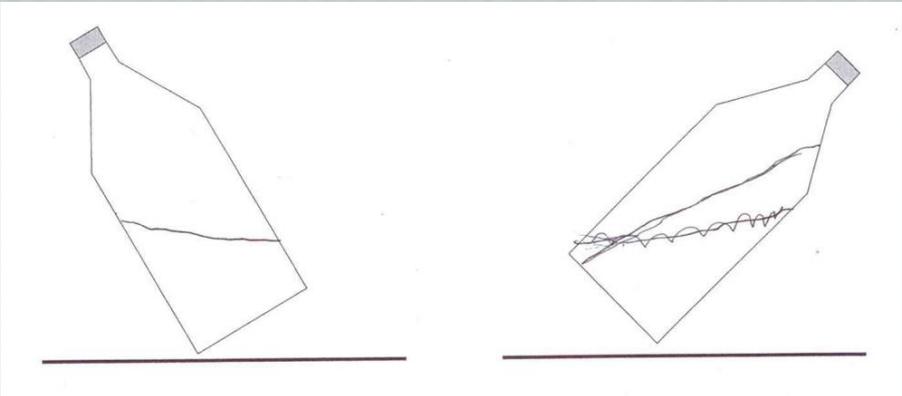
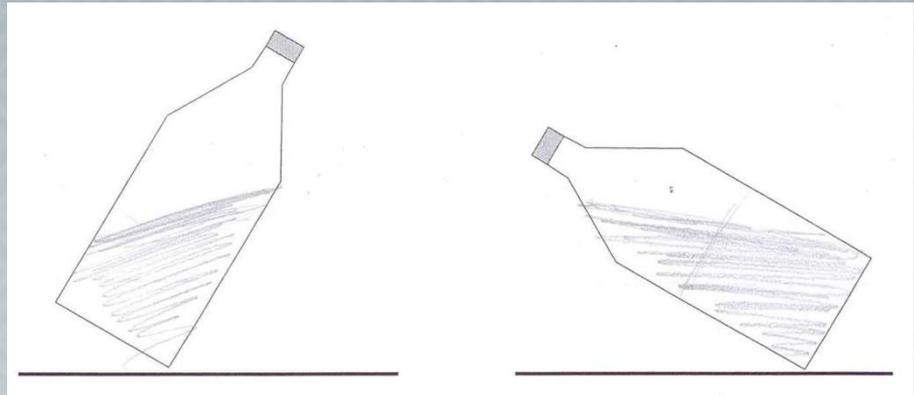
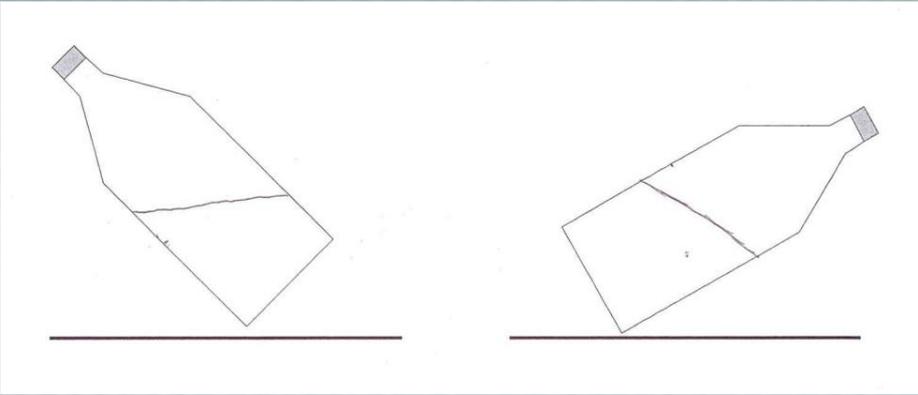


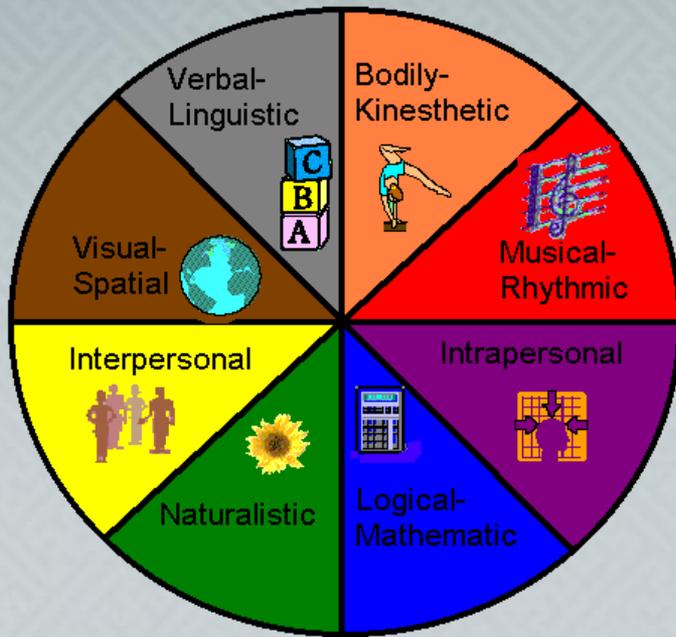
“Is Mental Rotation the Foundational Spatial Skill?”

Sorby et al., 2008,  
Michigan Technological  
University.

# Visualization, abilities, aptitude







Accurate mental visualization; Mental transformation of images.

The capacity to form mental imagery of the world—the large world of the aviator or navigator, or the more local world of the chess player or the surgeon—and to manipulate those mental images.

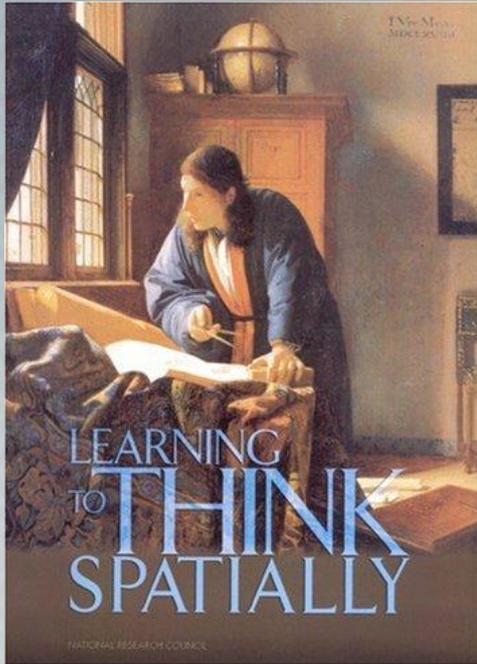
# Spatial thinking is...

an ability to visualize and interpret location, distance, direction, relationships, movement and change over space.

Sinton, 2009

**Spatial thinking** is a collection of cognitive skills based on:

- spatial concepts
- tools that we use to represent & understand spatial information and concepts
- ways we use those concepts and representations to reason and extract meaning about the natural and social world



### Spatial Concepts

location, distance, direction  
orientation, rotation  
scale  
shape, form, pattern  
networks, associations  
regions, transitions  
diffusion, flow, migration

### Tools of Representation

models (2D, 3D, 4D)  
maps (mental, concept, sketch, analog, digital)  
globes (traditional, digital)  
graphs, charts, figures  
principles of graphicacy

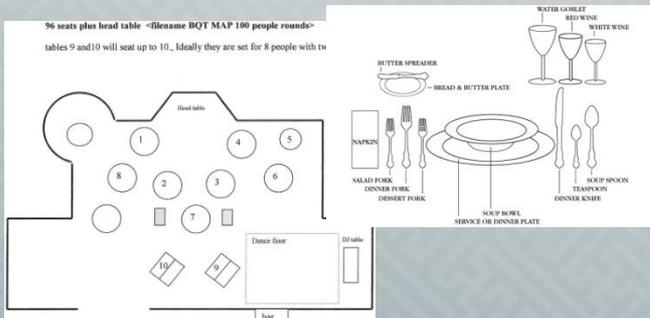
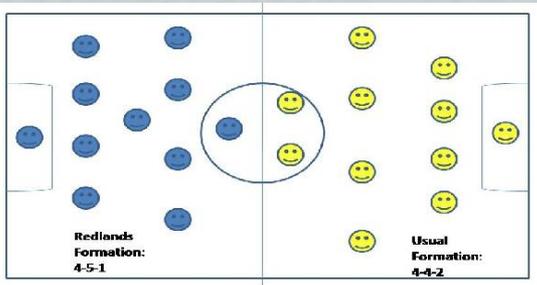
### Processes of Reasoning

making decisions based on interpretations of spatial data  
recognizing concepts of space within and between disciplines  
deducing possible causal factors based on pattern interpretation  
predicting alternative scenarios based on modeled behaviors of spatial interactions

## Thinking IN Space

### Geography of our Life Spaces

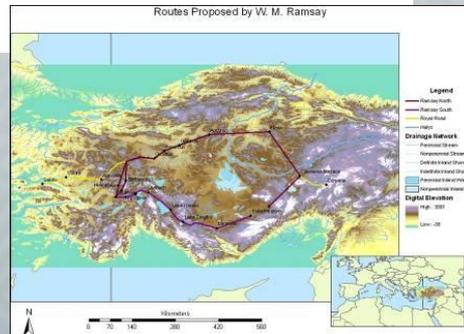
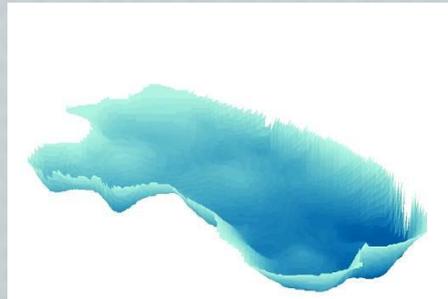
- Navigating, wayfinding
- Daily activities: arranging, figuring out, assembling, packing
- Gaming, athletics



## Thinking ABOUT Space

### Geography of our Physical Spaces

- How the physical world works and is organized
- Observing patterns, clusters, outliers/anomalies
- Modeling

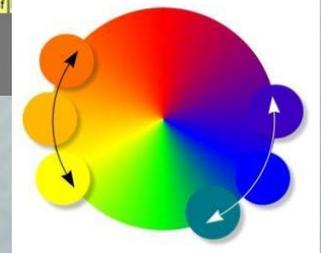
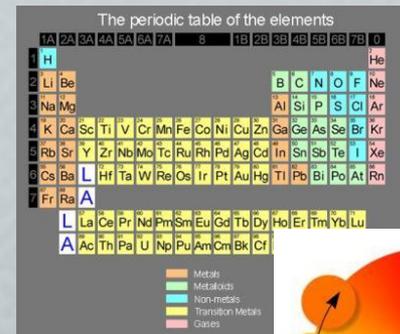


## Thinking WITH Space

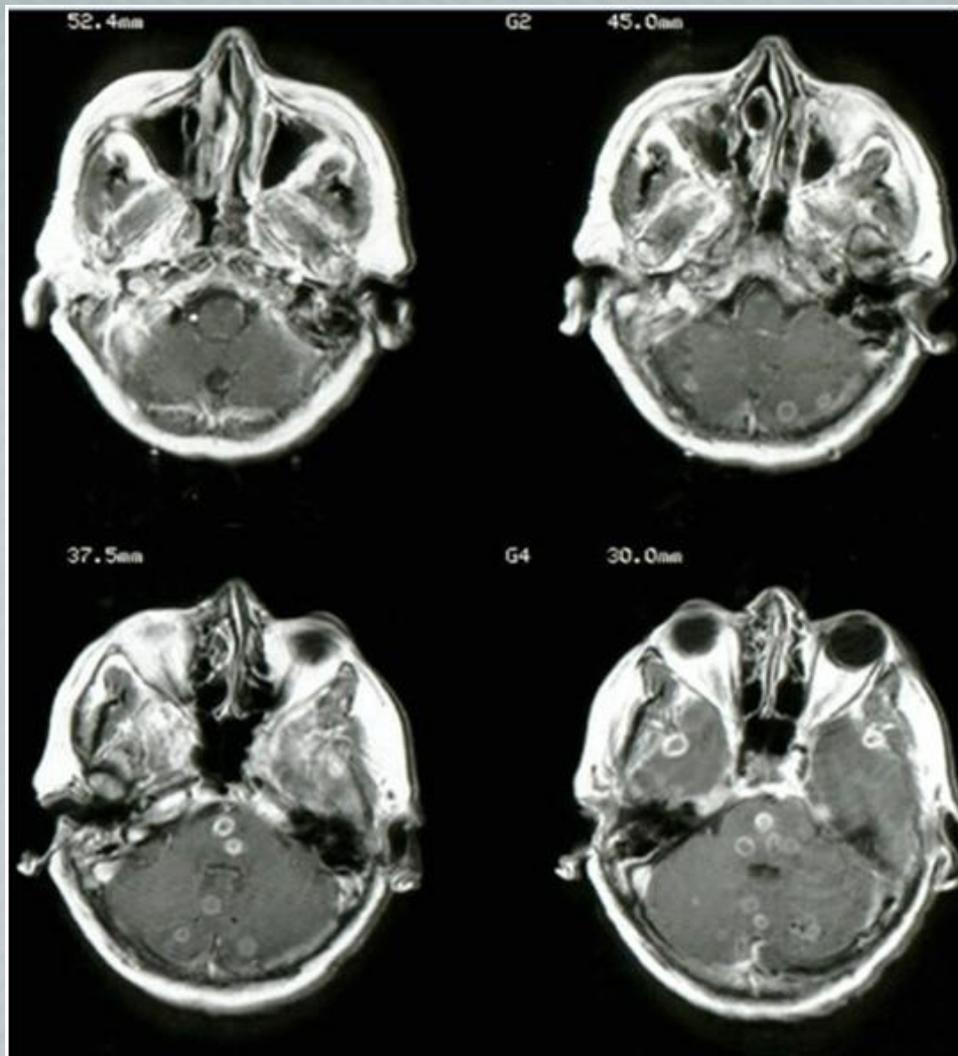
### Geography of our Intellectual Spaces

- Geographic or spatial primitives
- Concept maps
- Spatial relationships among abstractions

## “Spatializing” data







# Space, Maps and Geography: New Ways to Map a Changing World

**#1 Important Goal** - *We want to expand your awareness about the role of spatial thinking in your life and the world around you.*

- Space vs. Place (Yi-Fu Tuan, *Space and Place: The Perspective of Experience*)
- Thinking In, With, and About Space
- Spatial Concepts diagram
- Proxemics
- Day in the Life of a Spatial Thinker
  - categorizing spatial games
  - spatial language
  - videos, images
  - Find the spatial in.....
- DEMs
- Google Earth, examples of spatial concepts





When I Was 10 Maps (Edith Cobb, *The Ecology of Imagination in Childhood*)



[Save to My Maps](#)

### Alexs When I was Ten Map

4 views - Unlisted  
Created on Sep 23 - Updated Sep 23  
By [alexcosaro](#)  
[Rate this map](#) - [Write a comment](#)

#### [My School](#)

This is the school i went to in 5th grade

#### [Shape 1](#)



#### [Lynbrook High School](#)

This was the local high school. We were afraid t

#### [Dev's House](#)

This is my friend Dev's house We would always



#### [Miller Middle School](#)

Its a middle school



#### [Peter's House](#)

This is Peter's house, another place we hung ou



#### [Cool Porsche House](#)

This is the cool porsche house, it had a lot of c



#### [My House](#)

The map shows a satellite view of a city area with several streets labeled: Bolinger Rd, Prospect Rd, Lawrence Ego, County Rte 62, Saratoga Ave, Hamilton Ave, and S De Anza Blvd. A blue line traces a path through the city. Various markers are placed on the map, including a red Safeway logo, a 'NOB HILL FOODS' sign, and several small photos of people. A white callout box with a blue border and a close button in the top right corner contains the text 'No Go Zone' and 'Last Updated by alexcosaro on Sep 23'. The map interface includes a compass, a person icon, a scale bar (2000 ft / 500 m), and a copyright notice at the bottom: '©2008 Google - Imagery ©2008 DigitalGlobe, GeoEye, D. S. Geological Survey, Map data ©2008 Tele Atlas - Terms of Use'.

# sample of Spatial Language / Vocabulary

- tunnel vision
- narrow minded
- let's step back to see the big picture
- on top of it all
- to top it all off
- the bottom fell out of the argument
- at the breaking point
- thinking outside of the box
- feeling on top of the world
- look at it from another angle
- Wednesday is “hump day”
- top tier
- Leftist policies
- running around in circles
- back of the pack
- under cover
- close the loop
- tread on thin ice

Level: 0

## Russian Box

Next Piece:



Score:  
0

Lines:  
0

1. HARFOUSH
2. ZIALTE
3. JO

High Scores...

Start Quit Music On/Off

Left: A,4 Right: D,6 Speed Drop: S,5 Rotate CW: W,8 Rotate CCW: E,9

Drag the state on the lower left onto the map and drop it in its correct location



Game by Danny Barr, www.420a.com Music by Tim Hubert, www.420a.com



Points: 4/15 from 35

### spatialeyes

Round	Time	Score
1	89	0



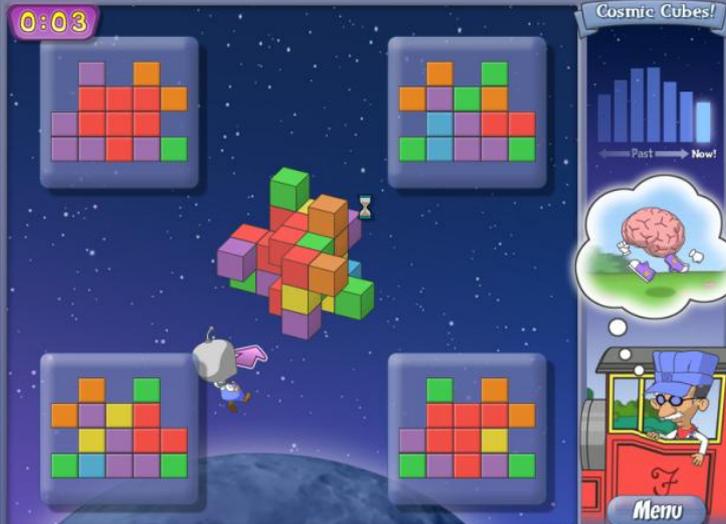
submit

Level: 24 Marbles: 2 Score: 31360 Time: 01:56



0:03

Cosmic Cubes!



Menu

# Spatial Games: Categories and Strategies

Wayfinding

Angles and Trajectories

Patterns

Areas of Influence / Auras

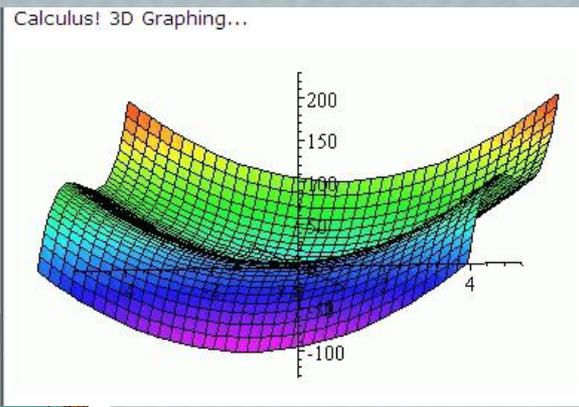
Rotations

Distances - Proximity and Adjacency

Combinations, Connections

Prior knowledge

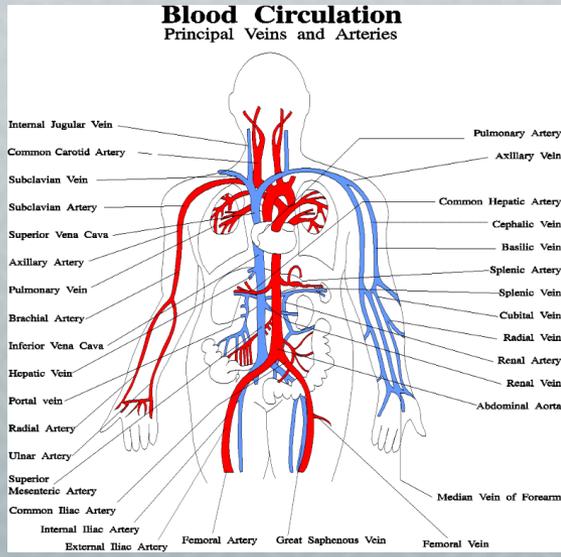
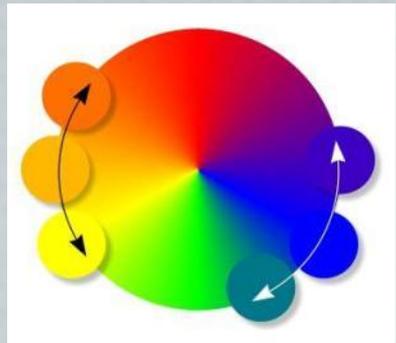
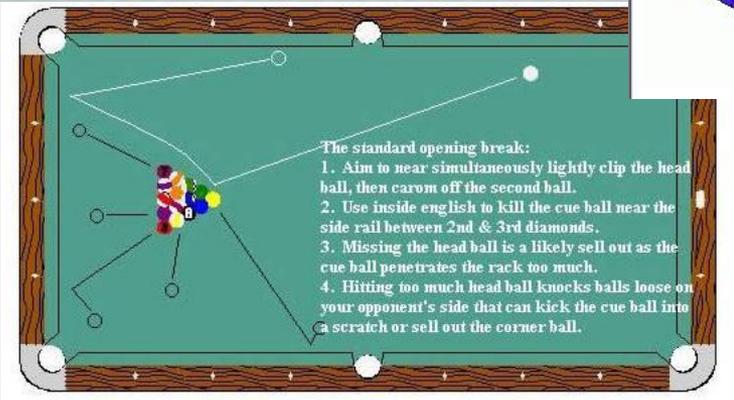
# Find the Spatial in....

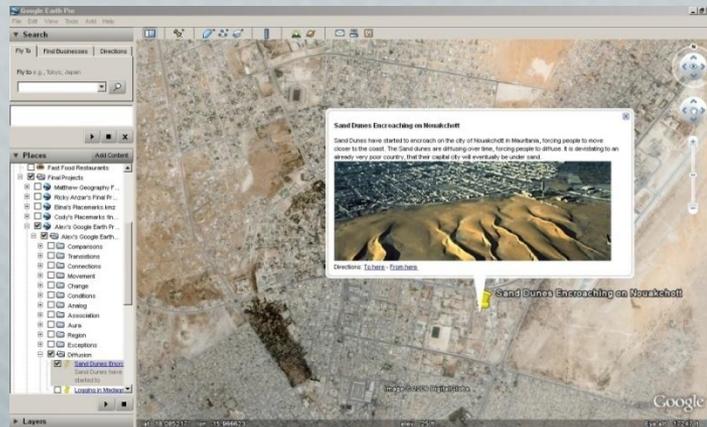
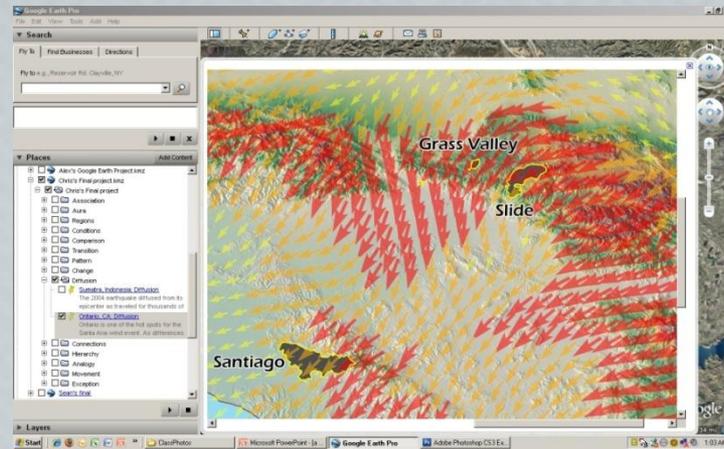
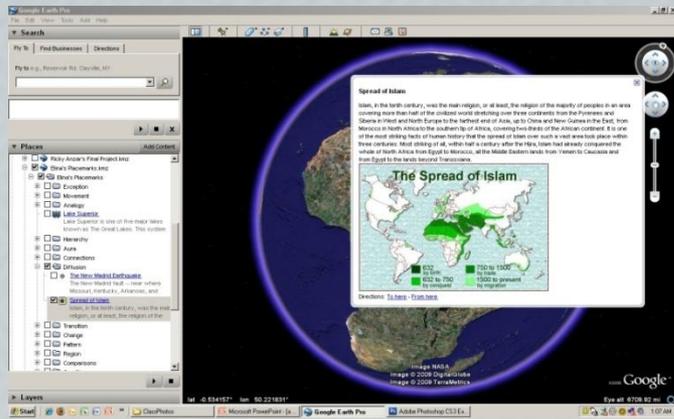
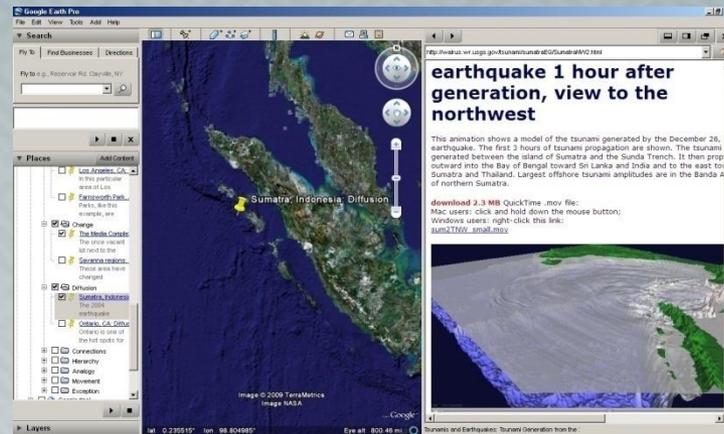


The periodic table of the elements

1A	2A	3A	4A	5A	6A	7A	8	1B	2B	3B	4B	5B	6B	7B	0		
1 H															He		
2 Li	Be										B	C	N	O	F	Ne	
3 Na	Mg										Al	Si	P	S	Cl	Ar	
4 K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5 Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6 Cs	Ba	L	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7 Fr	Ra	A															
		L	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		A	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

■ Metals  
■ Metalloids  
■ Non-metals  
■ Transition Metals  
■ Gases





# http://teachspatial.org

The screenshot shows the teachspatial.org website in an Internet Explorer browser window. The browser's address bar displays "http://teachspatial.org/". The website's header features a search bar with the text "Search this site:" and a "Search" button. Below the search bar is a navigation menu with buttons for "Concepts", "Schemas", "Resources", "Discussions", "Events", and "About TeachSpatial".

The main content area is titled "Navigation" and includes a link to the "TeachSpatial Blog". Below this is a "User login" section with fields for "Username:" and "Password:", a "Log in" button, and links for "Create new account" and "Request new password".

The "recent blog posts" section lists two posts: "a 'spatial concept' concept space" and "'spatial \_\_\_\_': collocated words by discipline".

The central text area features a quote: **"...spatial thinking** is pervasive: it is vital across a wide range of domains of practical and scientific knowledge; yet it is underrecognized, undervalued, underappreciated, and therefore underinstructed. **"** This quote is attributed to a "National Research Council 2006 report: [Learning to Think Spatially](#)".

Below the quote, the website describes itself as a collaborative, interactive web site devoted to improving our understanding of how spatial thinking contributes to science and society, and to providing resources that promote applications of spatial concepts and spatial tools in teaching and learning. The site features three parts:

- Part 1** enumerates and defines **core concepts** of spatial thinking, presented in the original words of authors from 18 source documents. Users of the site are invited to read the original publications to appreciate the contextual frameworks used by these authors. Please contribute to expanding the range of disciplines and specializations represented by suggesting additional source documents for inclusion.
- Part 2** presents **schemas** that interpret, synthesize, and model aspects of spatial thinking that draw on and interact with selected concepts from part 1. Please submit your own schema and explanatory text; and please join others with commentary and questions for on-line discussion.
- Part 3** will provide an archive of **user-contributed resources** for teaching and learning. Please share your pedagogic strategies, exercises, demonstrations, and course syllabi for use and consideration by others in their efforts to enhance spatial literacy.

The website also includes a sidebar with a "network" section and a "recent blog posts" section. The sidebar contains a "network" section with a diagram showing "network", "surface location", "boundary", and "spatial". Below this is a "recent blog posts" section with a diagram showing "3D and 3D", "internal structure", "orientation", and "properties".

- What are the connections between GIS and spatial thinking?
- Can GIS be used to help develop spatial thinking habits of mind?
- What is the role of GIS as a support-system for learning in K-12?

## **Table 1. Spatial Thinking Skills**

### **Spatial relations**

Abilities (skills) that recognize  
spatial distribution and spatial patterns  
Identifying shapes  
Recalling and representing layouts  
Connecting locations  
Associating and correlating spatially distributed phenomena  
Comprehending and using spatial hierarchies  
Regionalizing  
Comprehending distance decay and nearest neighbor  
effects in distributions (buffering)  
Wayfinding in real world frames of reference  
Imagining maps from verbal descriptions  
Sketch mapping  
Comparing maps  
Overlaying and dissolving maps (windowing)

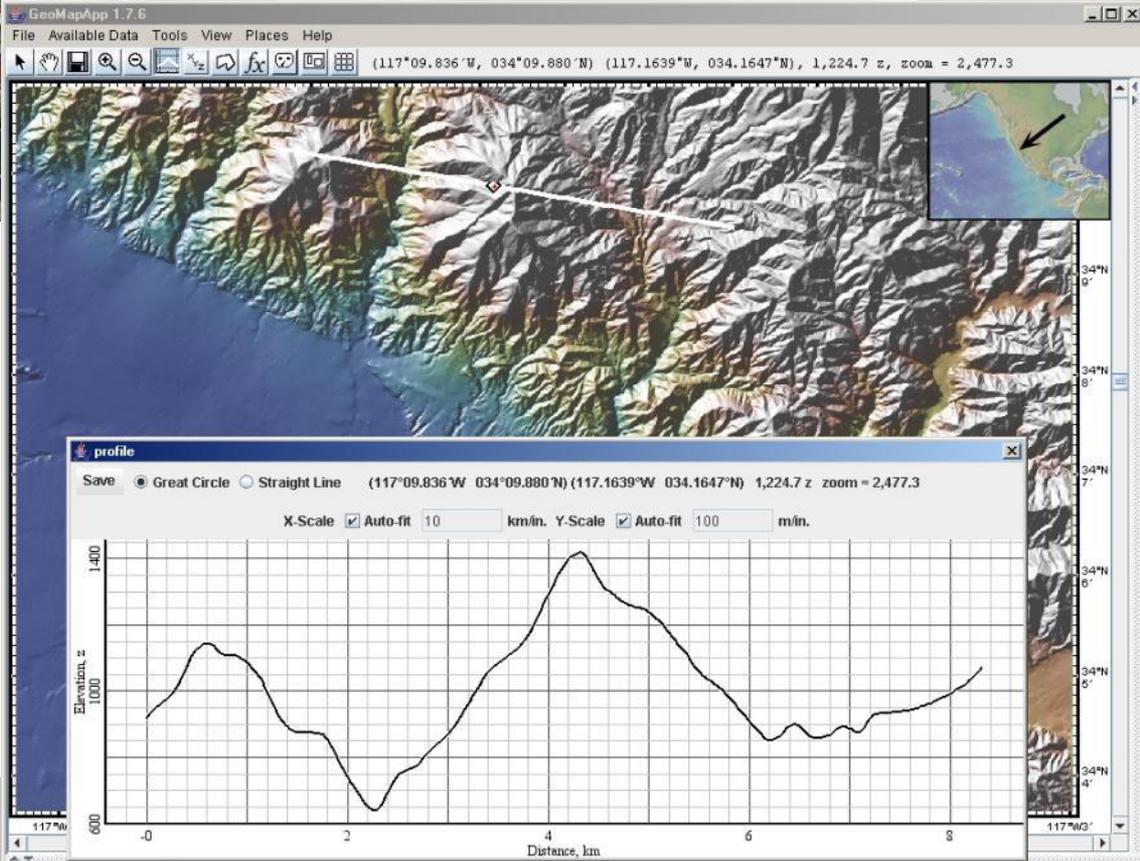
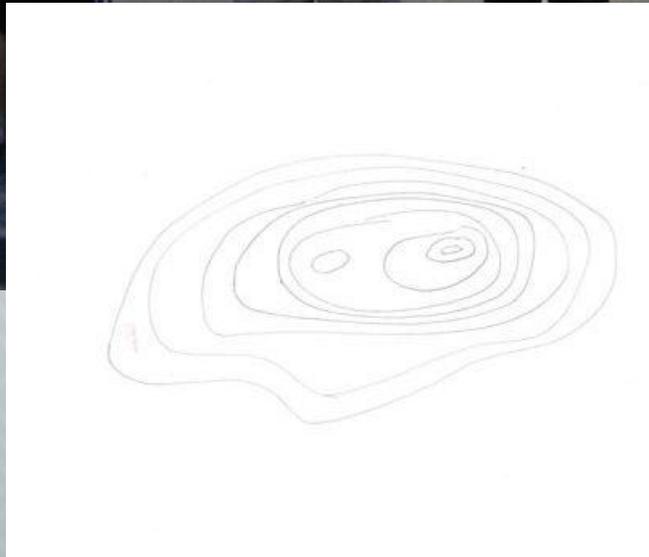
### **Processes used in cognitive mapping and GIS**

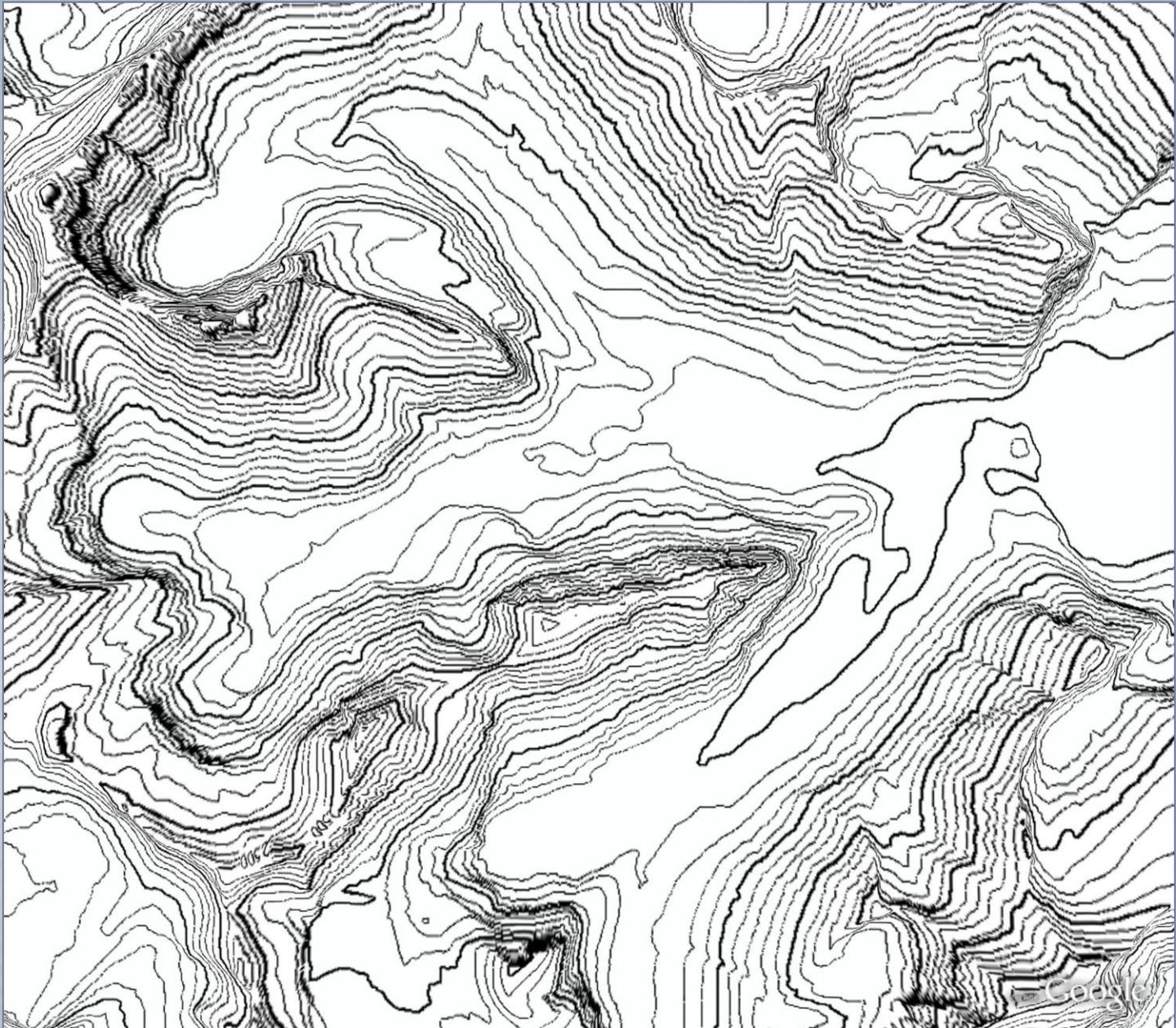
constructing gradients and surfaces  
layering  
regionalizing  
decomposing  
aggregating  
correlating  
evaluating regularity or randomness  
associating  
assessing similarity  
forming hierarchies  
assessing proximity (requires knowing location)  
measuring distance  
measuring direction  
defining shapes  
defining patterns  
determining cluster  
determining dispersion

Bednarz 2004, p 193.

# Seven Ideas to Help Begin to Link GIS with Spatial Thinking

- Identify when “**pre-GIS**” skills are necessary and have multiple and varied versions of materials that support that instruction.
- Do all you can to build up **frames of reference** – varying views and perspectives (2D and 3D) and recognizing the role of prior knowledge.
- When appropriate, attend to **location, distance and direction**.
- Don’t overlook the powerful role that **vocabulary** plays.
- Develop your own competence and confidence at **pattern** recognition and interpretation or analysis.
- Cultivate an awareness and appreciation of the **uncertainty** inherent within spatial data.
- Link maps and mapping to the broader picture of **graphicacy**.





**DELUGE, Scott Wilkerson, Geology, DePauw University**



Image © 2007 DigitalGlobe

© 2007

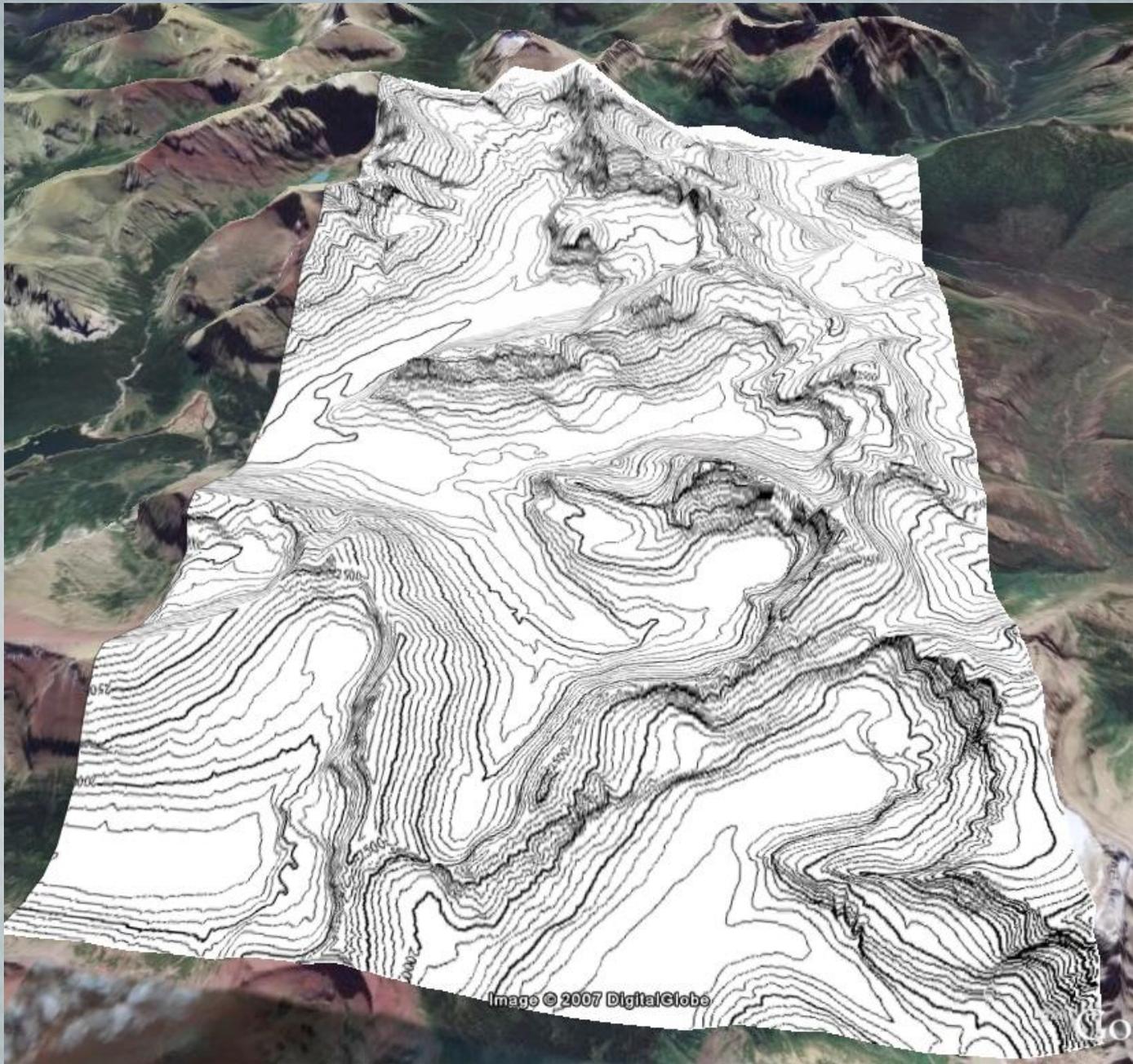


Image © 2007 DigitalGlobe

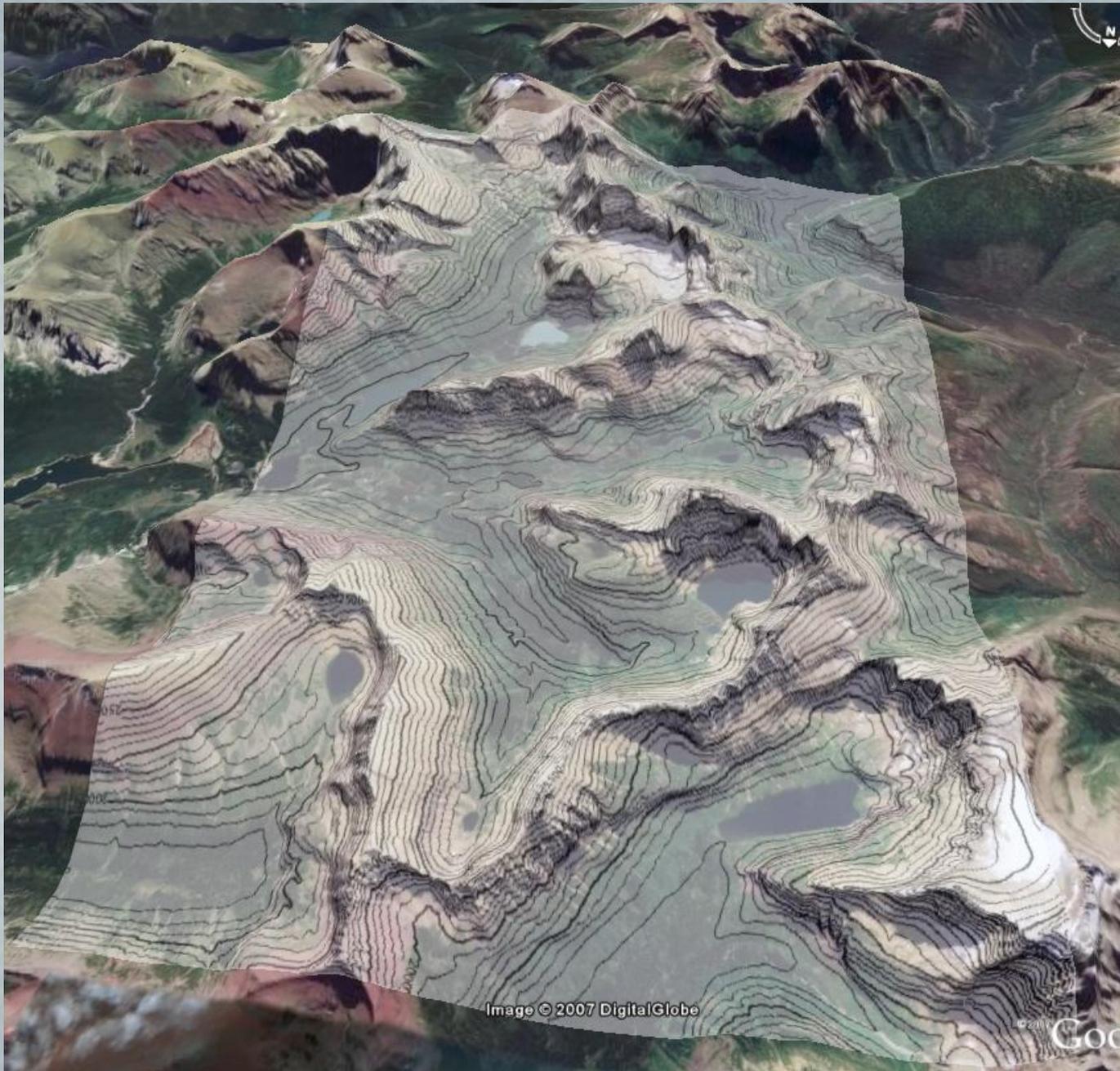
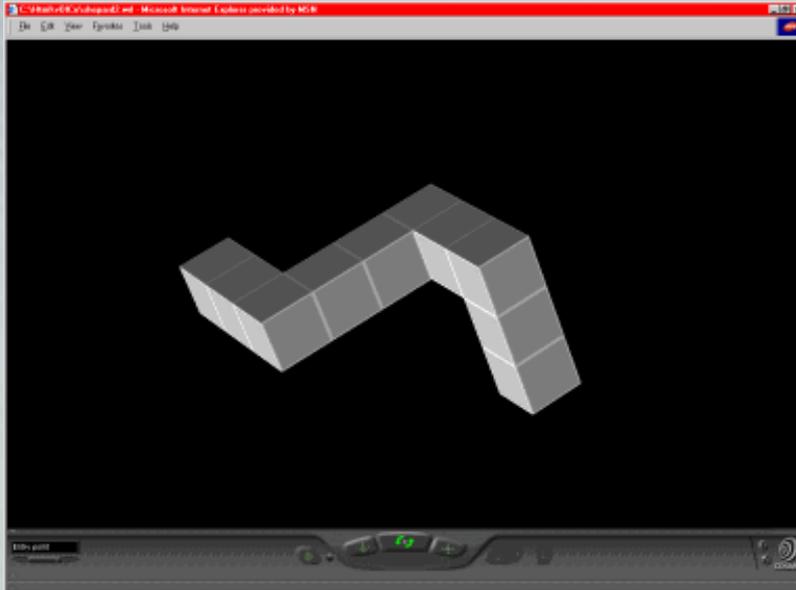


Image © 2007 DigitalGlobe

© 2011 Google

# Expand your Frames of Reference

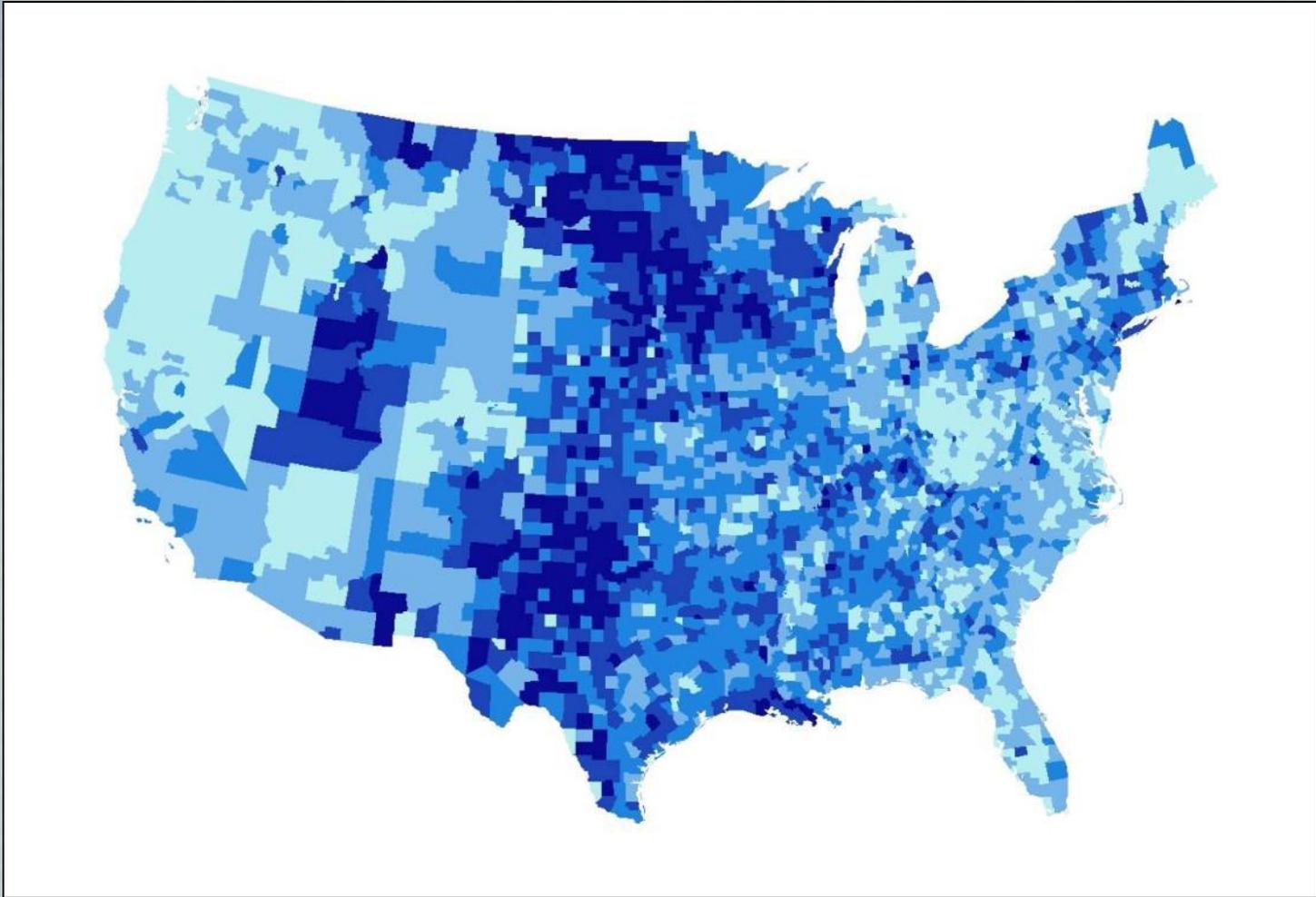


“Is Mental Rotation the Foundational Spatial Skill?”

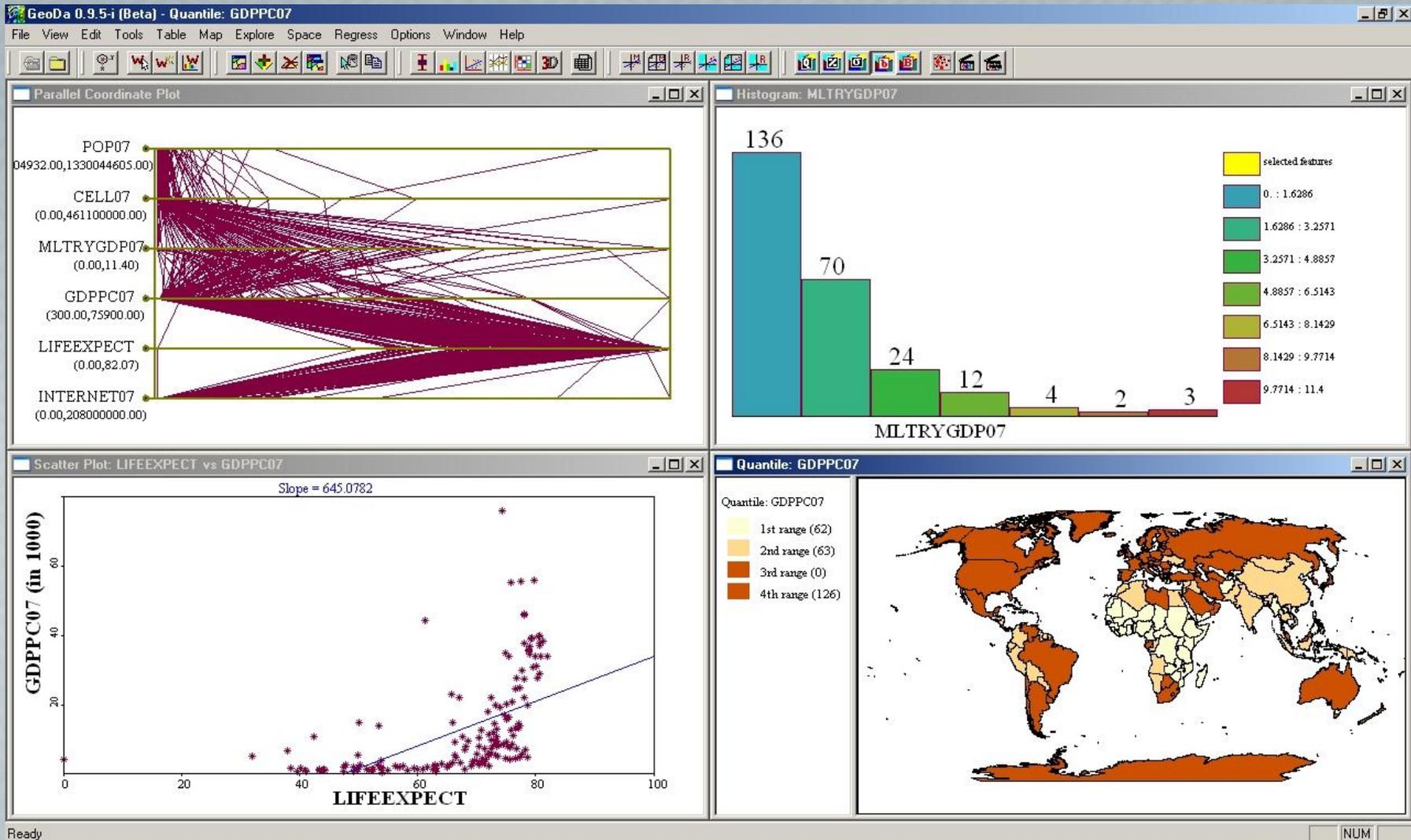
Sorby et al., 2008,  
Michigan Technological  
University

***change your perspective***





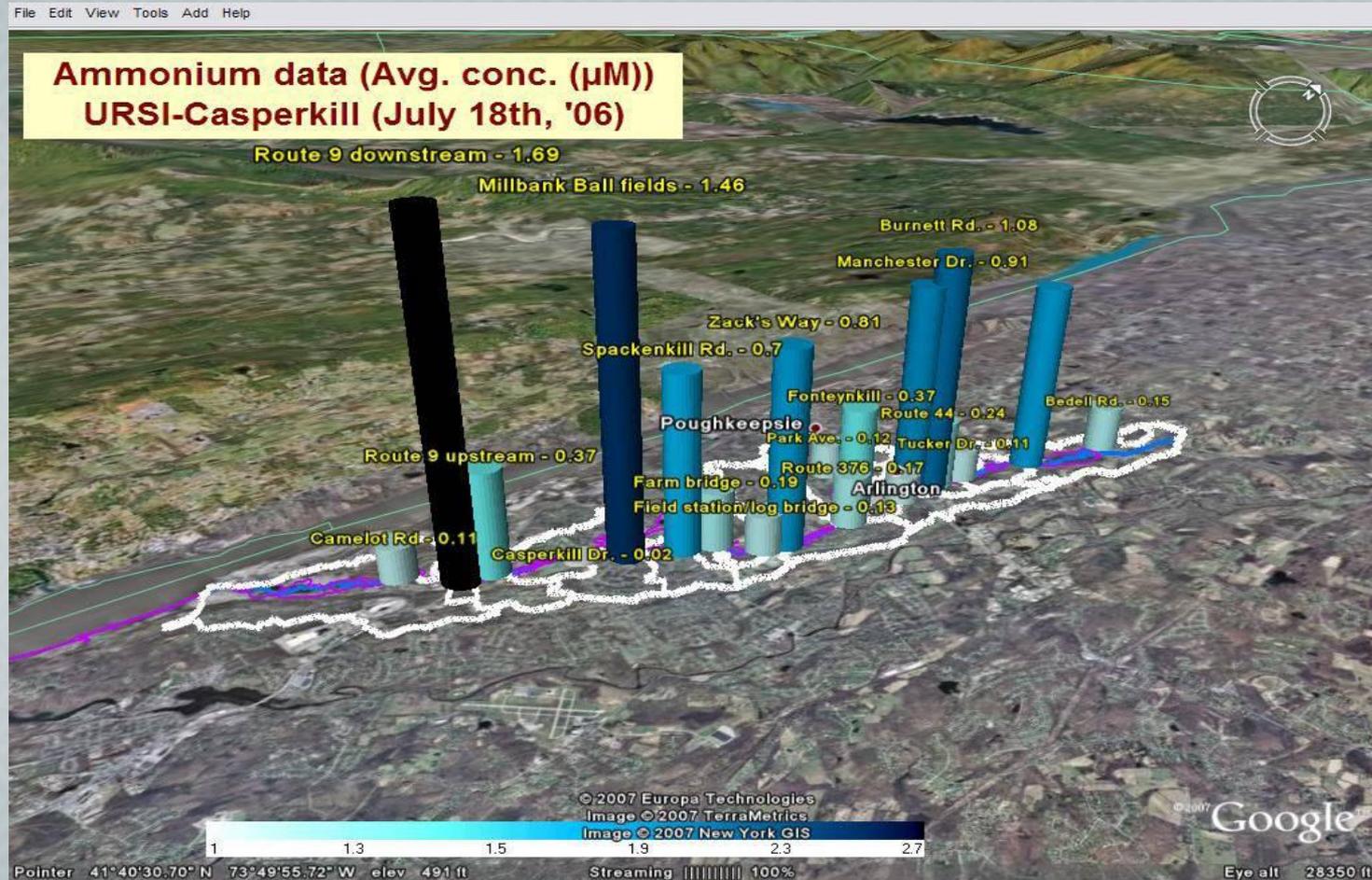
“It’s not something you would see until you actually saw it.”



GeoDa,  
<http://geodacenter.asu.edu/>

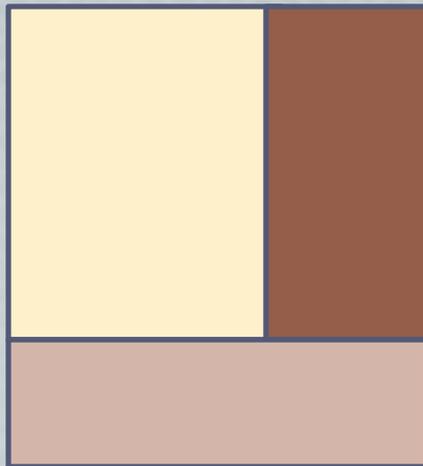


# Hands-on Science: Casperkill Creek

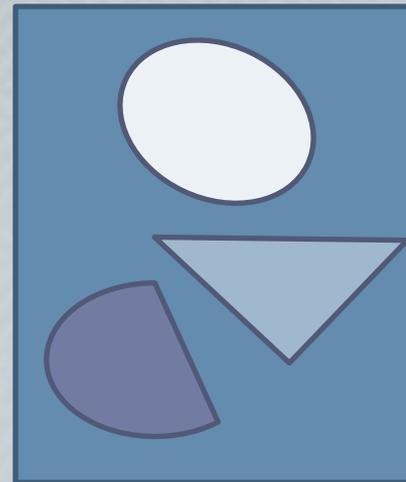


Data and graph provided by Meg Stewart. Satellite imagery provided by Google Earth™ mapping service.

crops



soils



# If assessment should be about what matters, what DOES matter in spatial thinking?

What matters is whether it's applied or not.

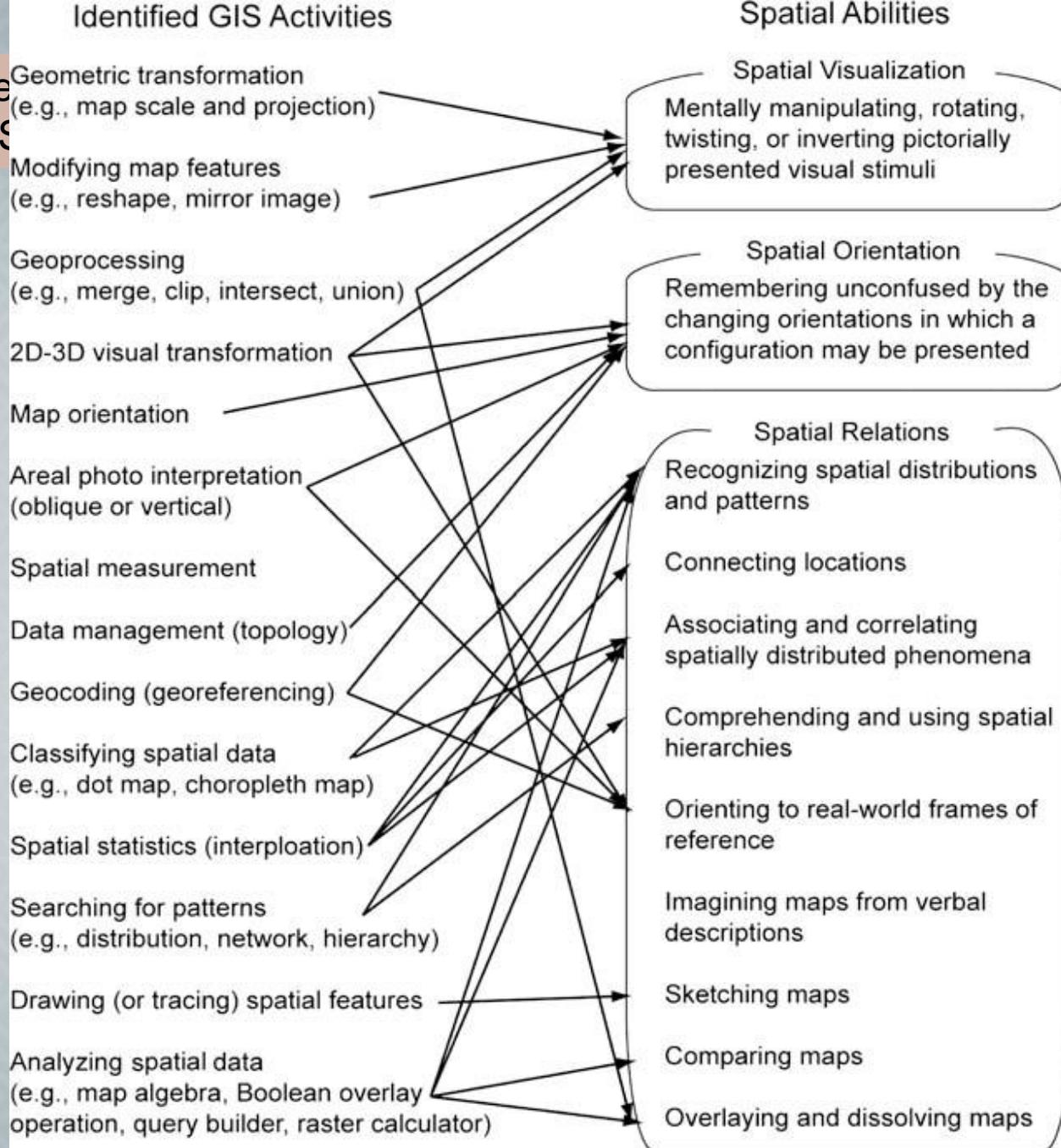
- Is there evidence that spatial reasoning was used to reach a conclusion?
- Were spatial vocabulary words used – correctly – in a description?
- Has the student made a drawing, a diagram, a sketch, a figure, a chart that represents the information or situation?
- Is there understanding shown about how distance (or direction, or hierarchy, or being part of a region, or XX) is affecting the relationship between A, B and Z?

It is (almost definitely) impossible to single out GIS as a “treatment” variable in learning. There will always be too many confounding variables and factors.

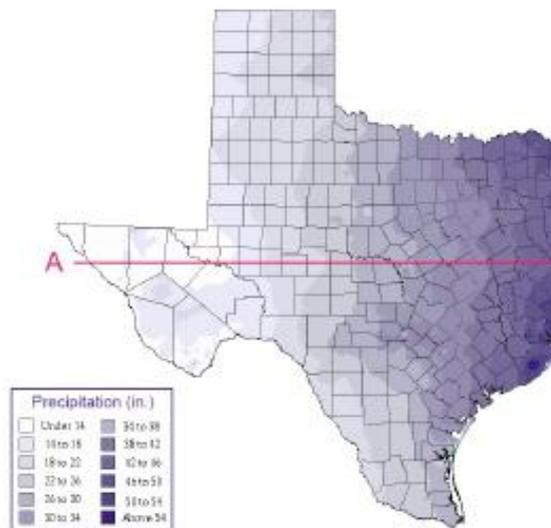
the technology?

or

how do we learn (extract meaning, understand information) from maps?



Direction: The map below shows annual precipitation of Texas.

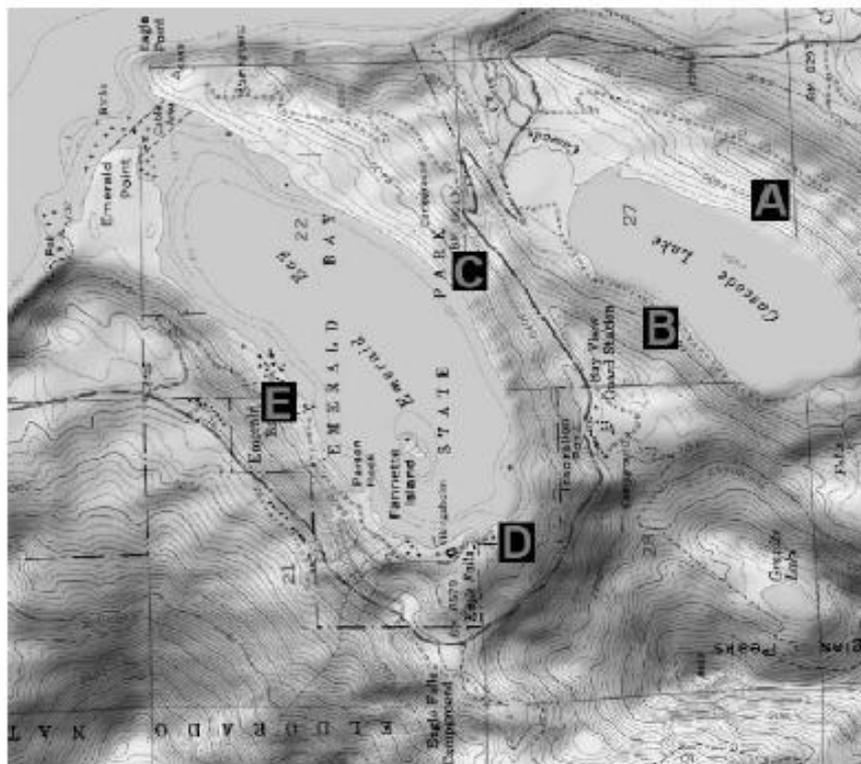
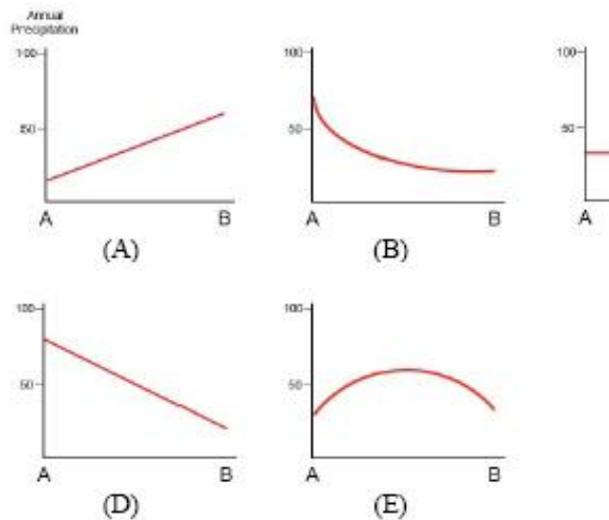


9. The following two images (3D and topographic map) show the same area. Find the matching location of an arrow of 3D map on the topographic map (A~E).

A ( ) B ( ) C ( ) D ( ) E ( )



3. If you draw a graph showing change of Texas annual precipi the graph will be \_\_\_\_\_ (choose closest one).



## Example of revised assessment question for an aquatic ecology class

Original final exam question, prior to the extensive use of mapping/GIS:

You have sampled water from Pine Hill Creek and monitored several indicators of water quality (pH, fecal coliform, BOD) over the last year. Discuss how the variables have changed over time and provide a rationale for why you believe this has occurred.

Revised final exam question, after the extensive use of mapping/GIS:

You have sampled water from Pine Hill Creek and monitored several indicators of water quality (pH, fecal coliform, BOD) over the last year. Draw a sketch of the Pine Hill watershed, including the locations of major land uses plus the flow pattern of ground and surface water. Mark your sampling locations and indicate where, how, and why the water quality indicators varied over the year.

THANKS!

Questions?

diana\_sinton@redlands.edu

<http://lens.redlands.edu>