

Using Geovisualizations That Incorporate Spatial Thinking, Real World Science and Ocean Literacy Standards in the Classroom

A Research Paper

Master of Science in Geography Oral Defense

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Department of Geosciences

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Dr. Dawn Wright, aka Deepsea Dawn



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What is a Geovisualization?

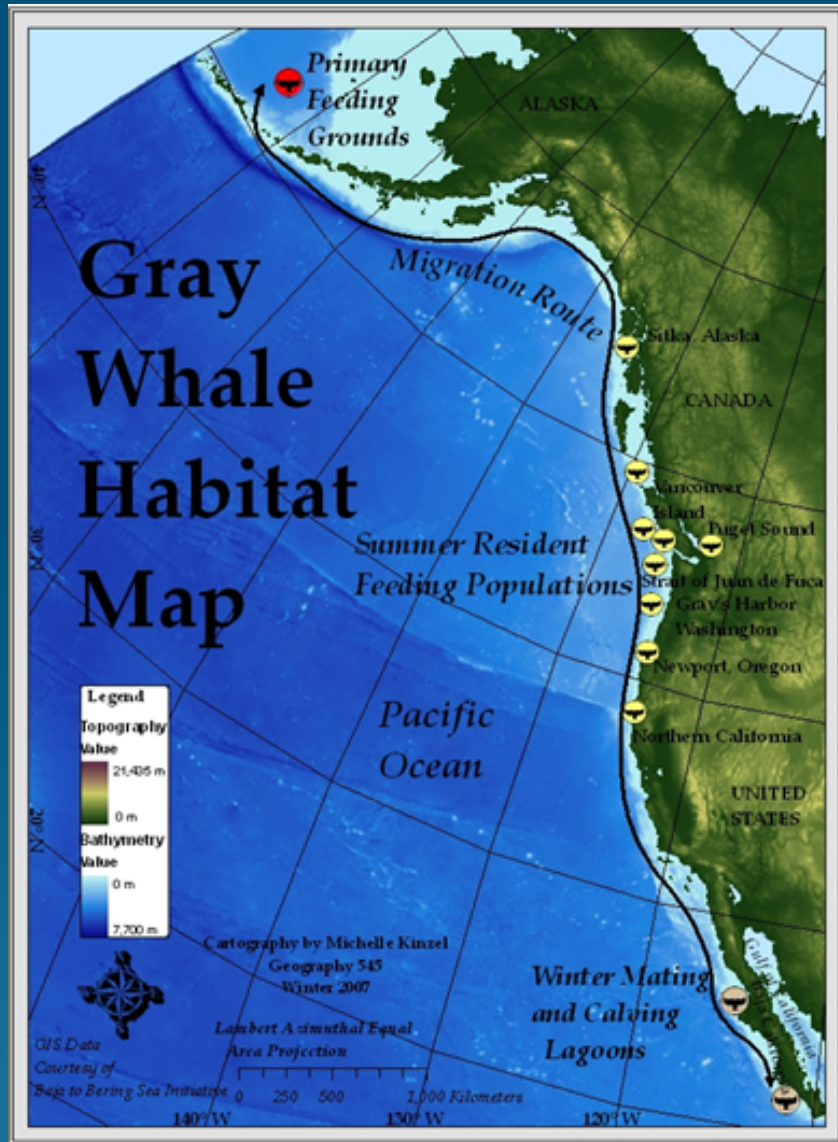
-A representation of a geographic concept or data set.

This research on **the use of geovisualizations** focuses on the tools and products of georeferenced data sets;

*Static geovisualizations *Mapping Software

*Dynamic geovisualizations *Serious Games

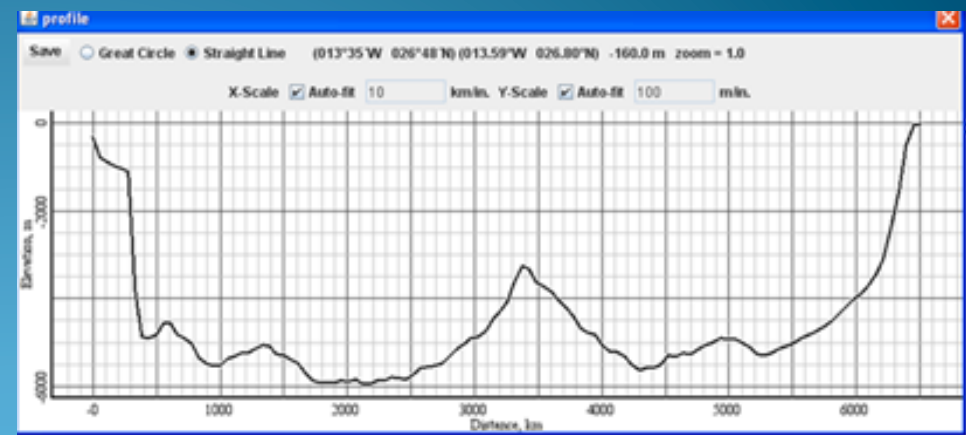
Static Geovisualizations



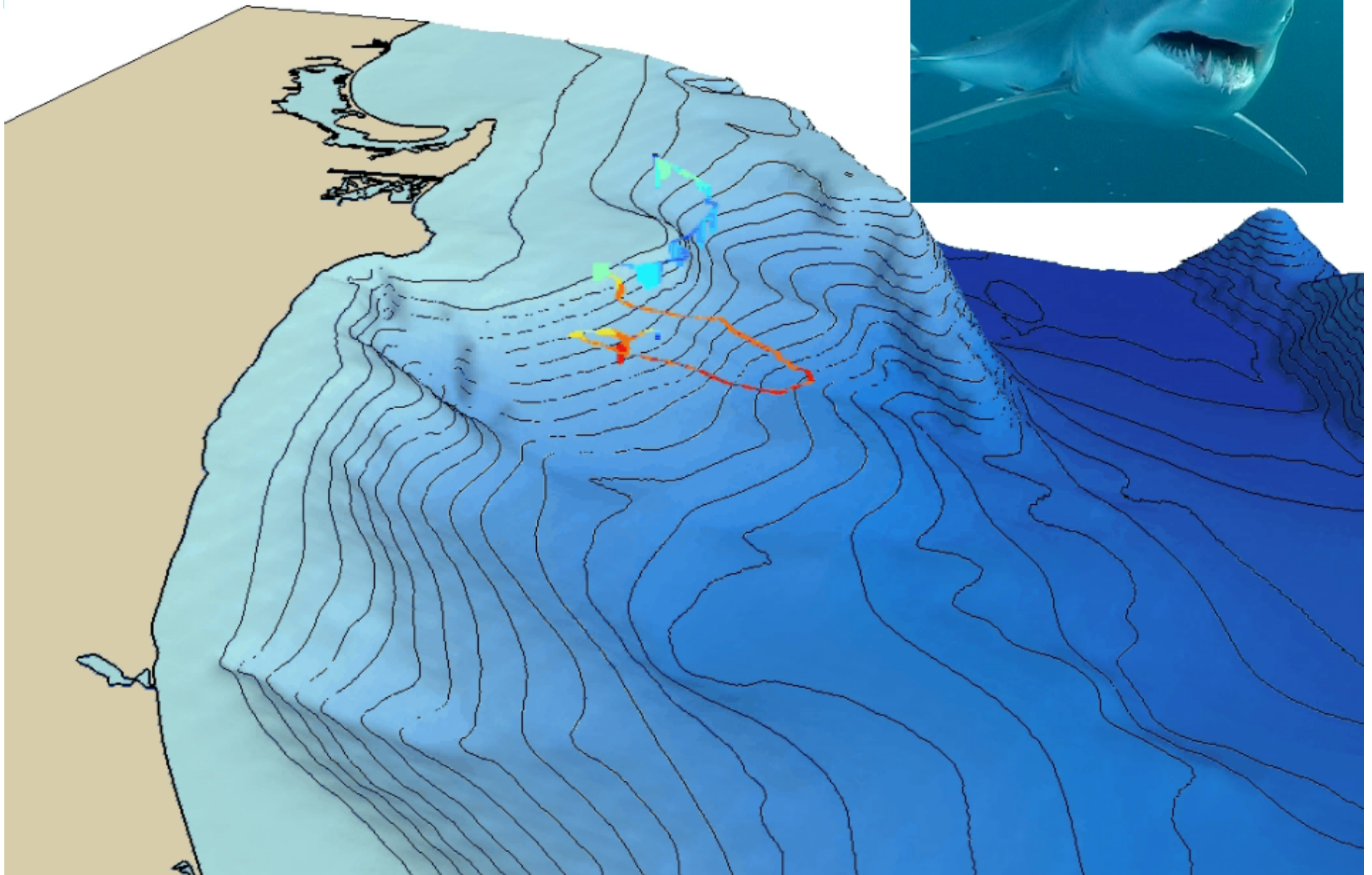
Attributes of keyfish

FID	Shape *	ISLAND	SITE	LATDD	LONGDD	DATE	OBSERVE	COMMONNAME
0	Point	SB	CAT	33.45667	-119.04639	6/19/1996	1	black surperch, all
1	Point	SB	CAT	33.45667	-119.04639	6/19/1996	2	black surperch, all
2	Point	SB	CAT	33.45667	-119.04639	6/19/1996	6	black surperch, all
3	Point	SB	CAT	33.45667	-119.04639	6/19/1996	4	black surperch, all
4	Point	SB	CAT	33.45667	-119.04639	6/19/1996	5	black surperch, all
5	Point	SB	CAT	33.45667	-119.04639	6/19/1996	9	black surperch, all
6	Point	SB	AP	33.48472	-119.03694	6/20/1996	4	black surperch, all
7	Point	SB	AP	33.48472	-119.03694	6/20/1996	9	black surperch, all
8	Point	SR	RR	34.02306	-120.11111	7/10/1996	7	black surperch, all
9	Point	SR	RR	34.02306	-120.11111	7/10/1996	4	black surperch, all
10	Point	SR	RR	34.02306	-120.11111	7/10/1996	5	black surperch, all
11	Point	SR	RR	34.02306	-120.11111	7/10/1996	2	black surperch, all
12	Point	SR	RR	34.02306	-120.11111	7/10/1996	8	black surperch, all
13	Point	SR	RR	34.02306	-120.11111	7/10/1996	1	black surperch, all
14	Point	SR	RR	34.02306	-120.11111	7/10/1996	9	black surperch, all
15	Point	SC	GI	33.95	-119.825	7/11/1996	4	black surperch, all
16	Point	SC	GI	33.95	-119.825	7/11/1996	3	black surperch, all

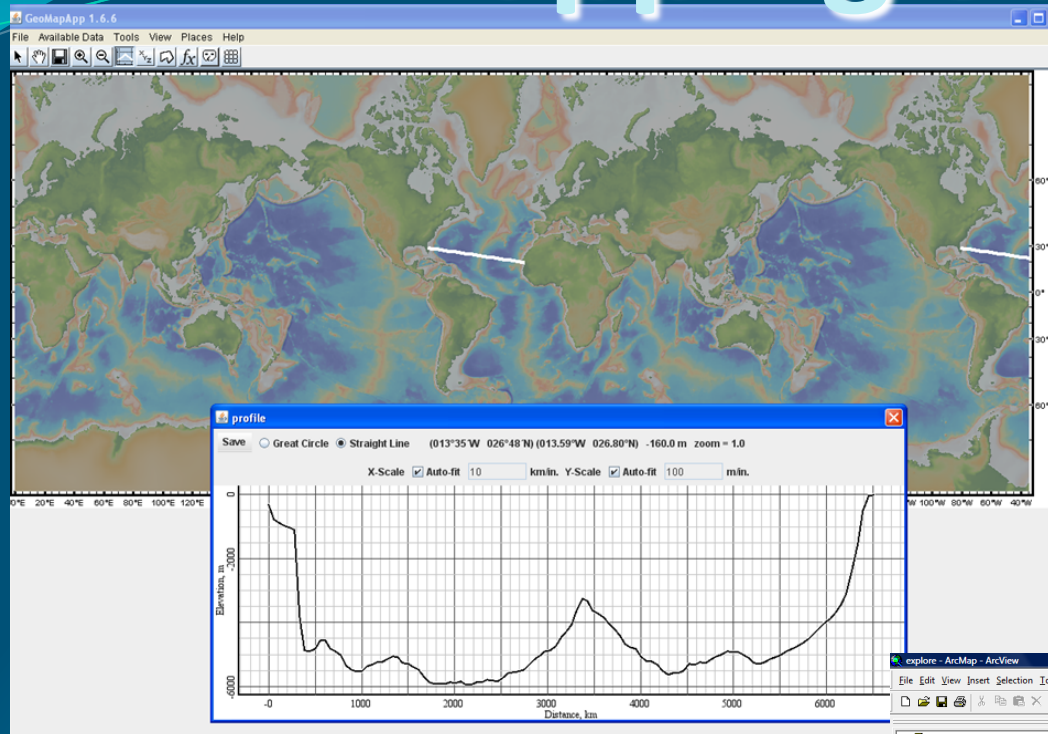
Record: 1 Show: All Selected Records (0 out of 9799 Selected) Options



Dynamic Geovisualizations

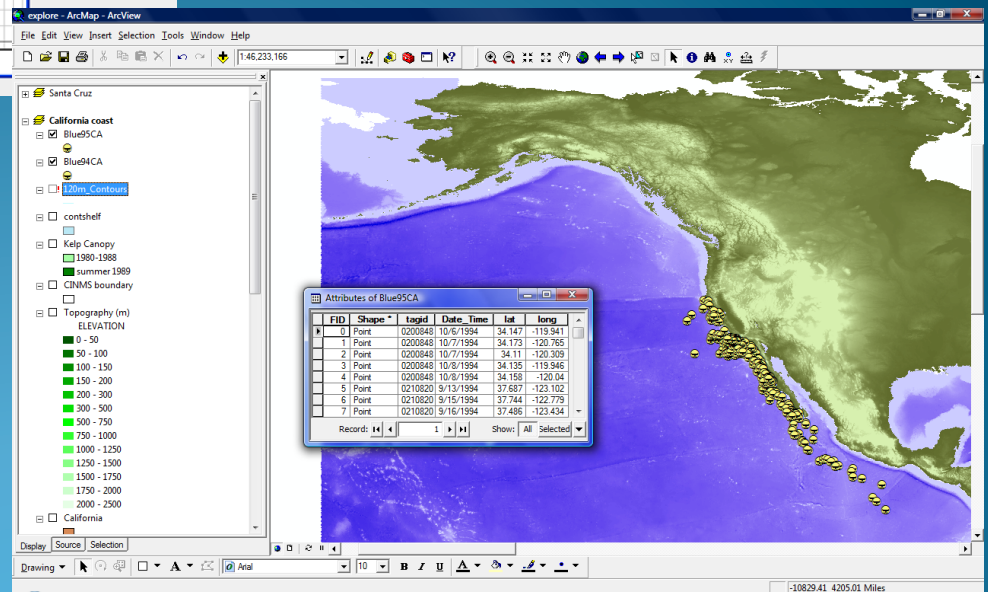


Mapping Software

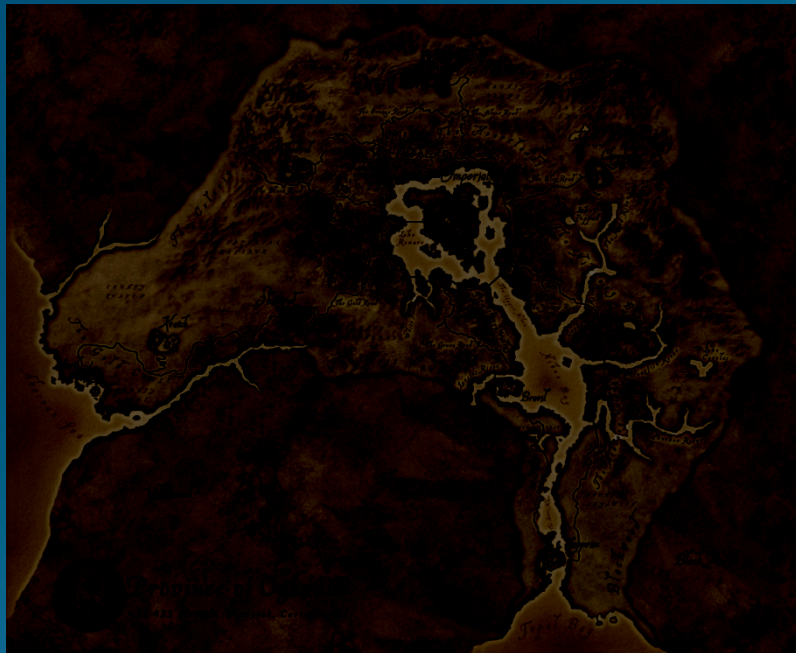


GeoMapApp

ArcGIS



Serious Games (Interactive Animations)



Elder Scrolls
Commercial Product



Flight Simulators
Microsoft

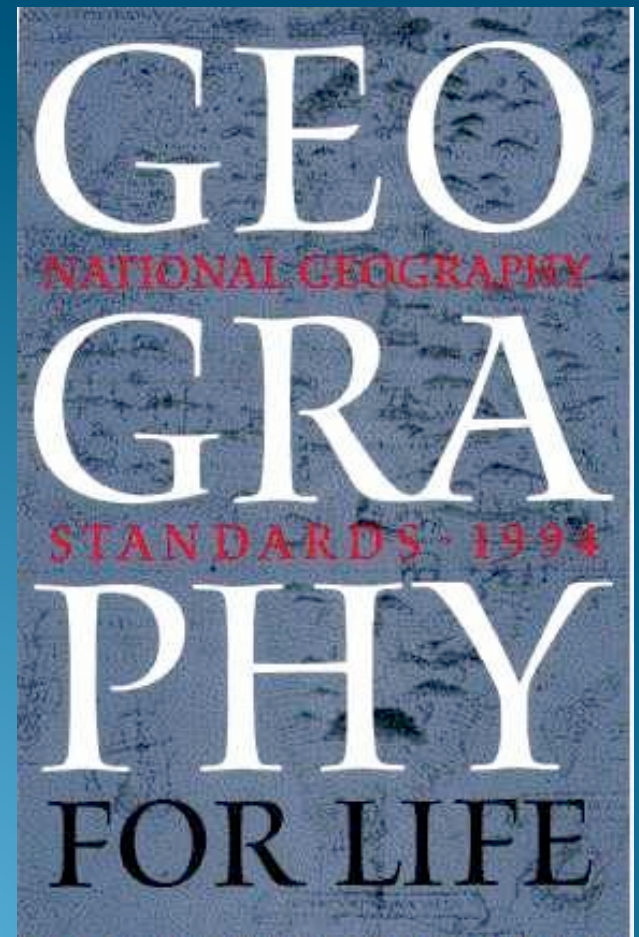
Geography for Life

National Geography Standards. 1994. *Geography for Life*. Washington, D. C.
National Geographic Research and Education. 272 p.

❖ 18 Standards,
Benchmarked for Grades
4,8,12

❖ 6 Essential Elements

❖ 5 Skill Sets

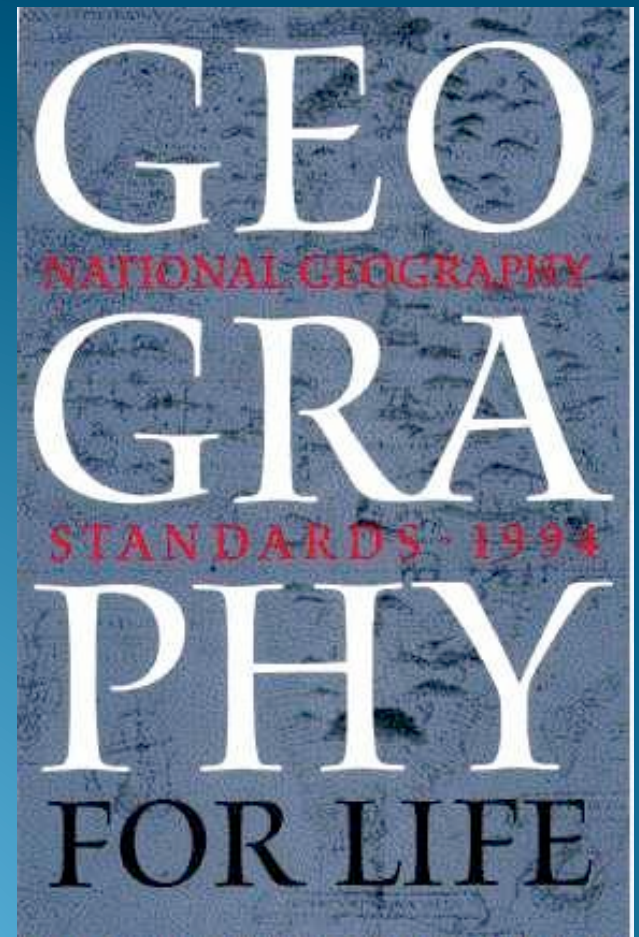


Geography for Life

National Geography Standards. 1994. *Geography for Life*. Washington, D. C. National Geographic Research and Education. 272 p.

❖ 6 Essential Elements

- ❖ The World in Spatial Terms
- ❖ Places and Regions
- ❖ Physical Systems
- ❖ Human Systems
- ❖ Environment and Society
- ❖ The Uses of Geography



Geography for Life

National Geography Standards. 1994. *Geography for Life*. Washington, D. C. National Geographic Research and Education. 272 p.

❖ 5 Skill Sets

Asking questions

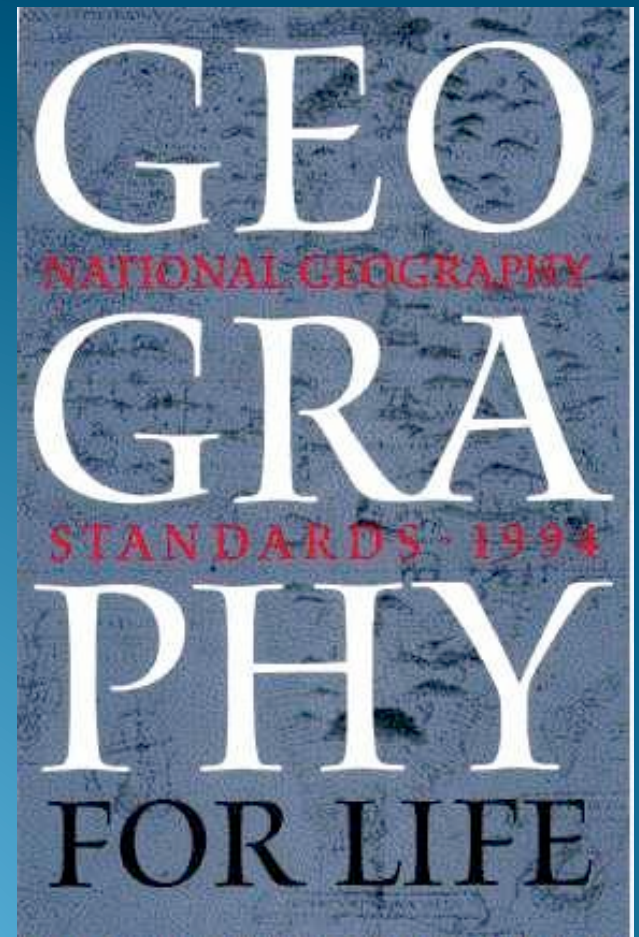
Acquiring information

Organizing information

Analyzing information

Answering questions

❖ *Tools and techniques
to enable us to think spatially*



Geographically informed?

Chain of knowledge

People, place and environment

Choices:
Live, Work,
Travel, Shop, Vote

PROCESS OF ACTION

Process
Information:
Evaluate
reliability

Resource Base:
land, climate,
physical geography

SPATIAL INFORMATION

Human/Cultural factor:
population, community
human geography



Geography for Life

A Geographically Informed Person;

- (1) sees meaning in the arrangement of things in space;**
 - (2) sees relations between people, place and environments;**
 - (3) uses geographic skills; and**
 - (4) applies spatial and ecological perspectives to life situations.**
- (Geography for Life, 1994).**

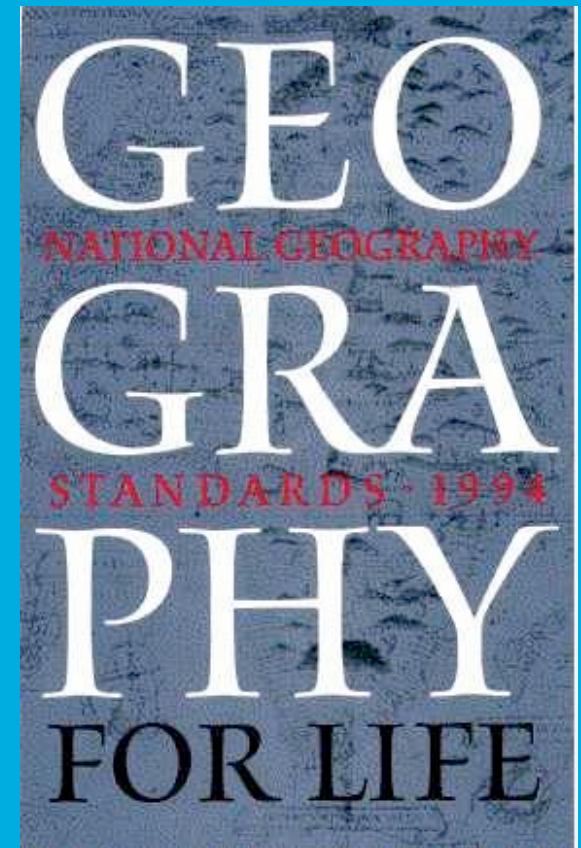
Standards universally applicable

Unique emphasis by region



Recognized Importance of Geographic Literacy

- 1994 Act of Congress, Goals 2000: Educate America Act; students should “leave grades 4, 8 and 12 having demonstrated competency over challenging subject matter (including Geography).
- National Geography defines 18 Standards, in great detail!



But is this happening.....?

Schools Report Cards

Geographic (il)Literacy

- 12th graders scored 281 out of 500, a 56.2% average on nationwide evaluation of geographic literacy
(1994, National Assessment of Educational Progress)
- In 2001, scores only improved to 56.8%
- Young adults 18-24 came in 8th out of 9 countries included in Global Geographic Literacy Survey
(National Geographic-Roper, 2002)

Schools Report Cards

Geographic (il)Literacy

- “No Child Left Behind”, 9 key areas, Geography only one not funded
- In rush to accountability, social studies at elementary level is being left behind; math and reading are emphasized
- This will magnify through the system, and secondary levels will soon be impacted even more

Bloom's Taxonomy

Bloom's Taxonomy	Learning Skill	Multimedia Tool			
		Geovis Static	Geovis Dynamic	Mapping Software (GMA [†] , GIS [‡])	Serious Game (Interactive animations)
Knowledge	Memorization and recall	*	*	*	*
Comprehension	Understanding	*	*	*	*
Application	Using Knowledge	*	*	*	*
Analysis	Taking apart Information	*	*	*	*
Synthesis	Reorganizing information			*	*
Evaluation	Making judgments			*	*

Standards and Geovisualizations

National Geographic Standards

6 Essential Elements

I. The World in Spatial Terms

II. Places and Regions

III. Physical Systems

IV. Human Systems

V. Environment and Society

VI. The Uses of Geography

Standards and Geovisualizations

Standard <i>The geographically informed person knows and understands:</i>	Geovisualization Static	Geovisualization Dynamic	Mapping Software	Serious Game
<i>I. The World in Spatial Terms</i>				
1. How to use maps and tools to acquire, process and report information from a spatial perspective	* A,S	* S	* A,S	* A,S
2. How to use mental maps to organize information about people, places, and environments in a spatial context	* A		* S	* S
3. How to analyze the spatial organization of people, places, and environments on Earth's surfaces	* A,S	* S	* A,S	*

Using Geovisualizations

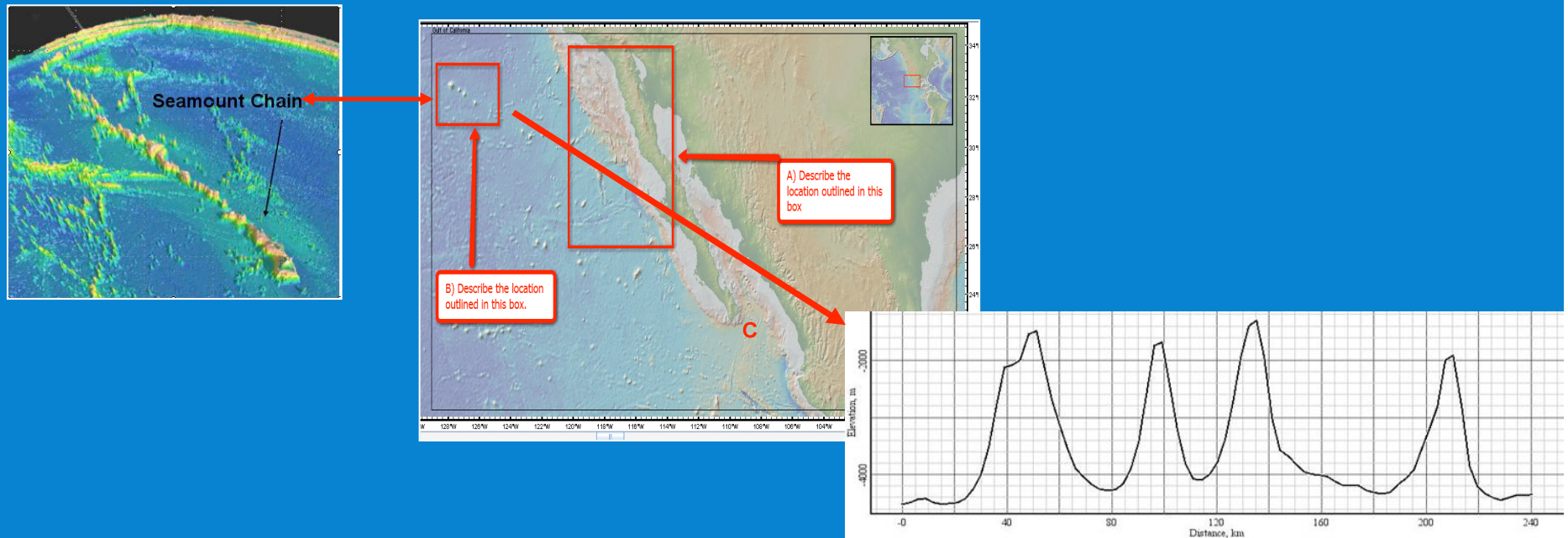
- **Static**; most diverse for standards
- **Dynamic**; more interesting and convey complex concepts or complicated data sets
- **Mapping Software**; more engaging, more active learning, increased time investment for technical support and teacher training
- **Serious Game**; highest appeal for students, most time investment to adapt in educational setting
- All of these tools are useful in education.

Research Based Proof

With 'No Child Left Behind Act of 2001' school systems and educators need evidence-based research to make decisions that will impact curriculum or teaching methodologies

"GIS teaching and curriculum development strategies should begin with an assessment of student understanding of spatial relationships and continue with a progression that spirals according to student cognitive mapping skills over time."

Journal of Geography, Special Edition on Research in GIS Education, November 2003.



Do the Tools Work?

Case Study; Corvallis High School

The four primary questions this study addresses are:

- 1) What advantages are there to using an interactive, immersive geovisualization in the design and implementation of curriculum at the high school level?**
- 2) How can multimedia technologies best be utilized in aiding students to achieve the educational standards related to geography, science and technology?**

Do the Tools Work?

Case Study; Corvallis High School

The four primary questions this study addresses are:

3) What pedagogical issues in secondary school curriculum development can be addressed with the use of interactive, immersive geovisualizations?

4) How does the use of real world scientific data sets enhance educational practices?

Do the Tools Work?

Case Study; Corvallis High School Activities



Pre Assessment; baseline

GPS Exercise

Field Work

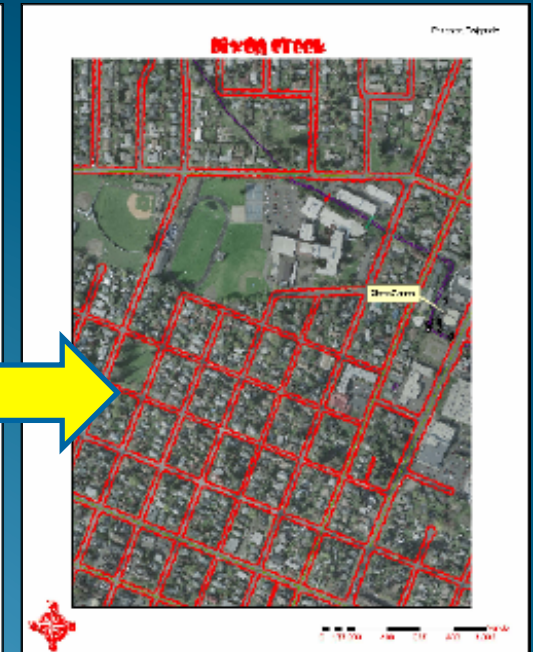
Computer Mapping

Post Assessment; any changes?

Case Study; Corvallis High School

Activities

GPS Units



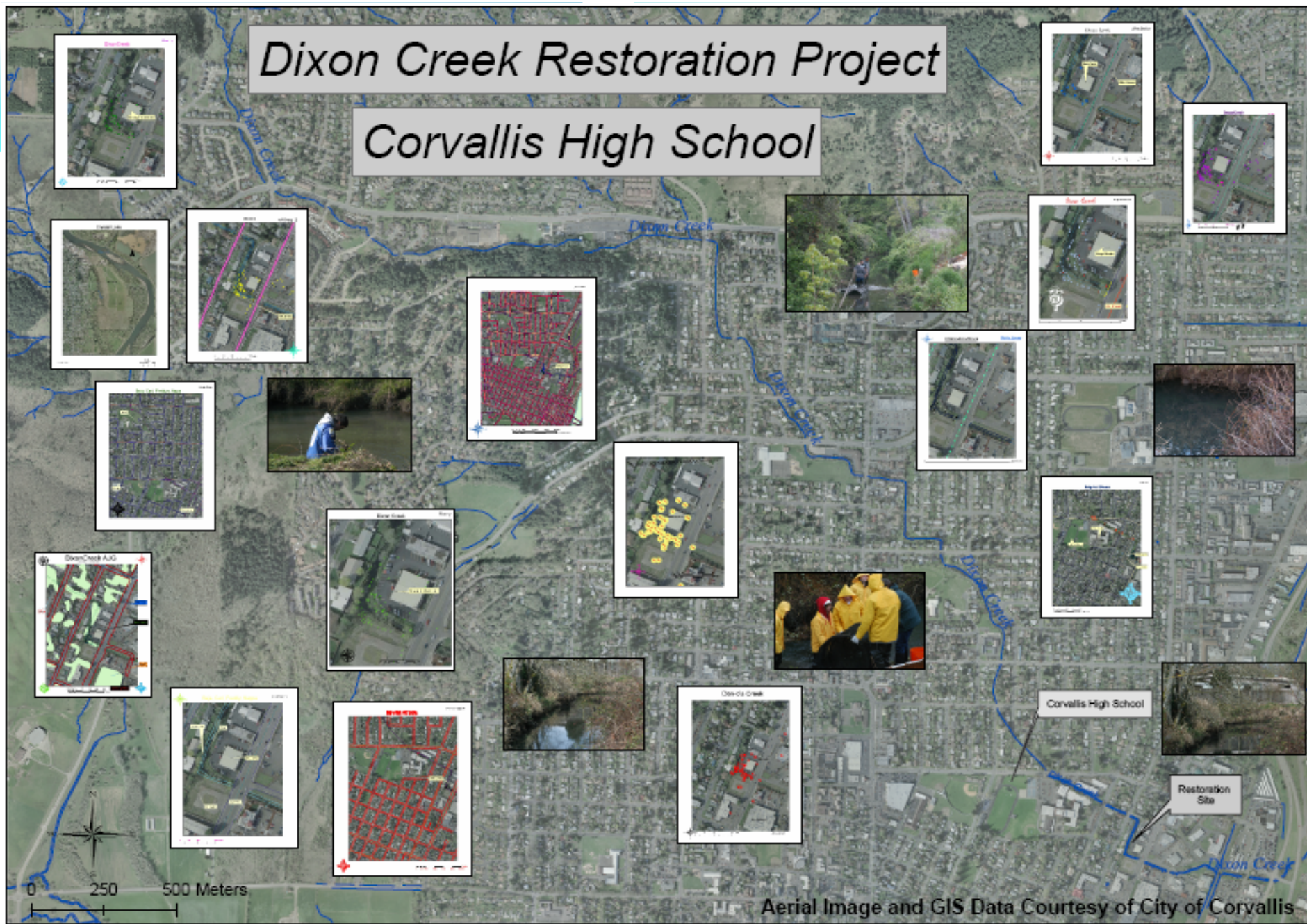
GIS Data

GIS Map Making

Field Work at Dixon Creek

Dixon Creek Restoration Project

Corvallis High School



Aerial Image and GIS Data Courtesy of City of Corvallis



Maps created by Corvallis High School Students
Mr. Wake's Class, 2007-08
Layout prepared by Michelle Kinzel, OSU



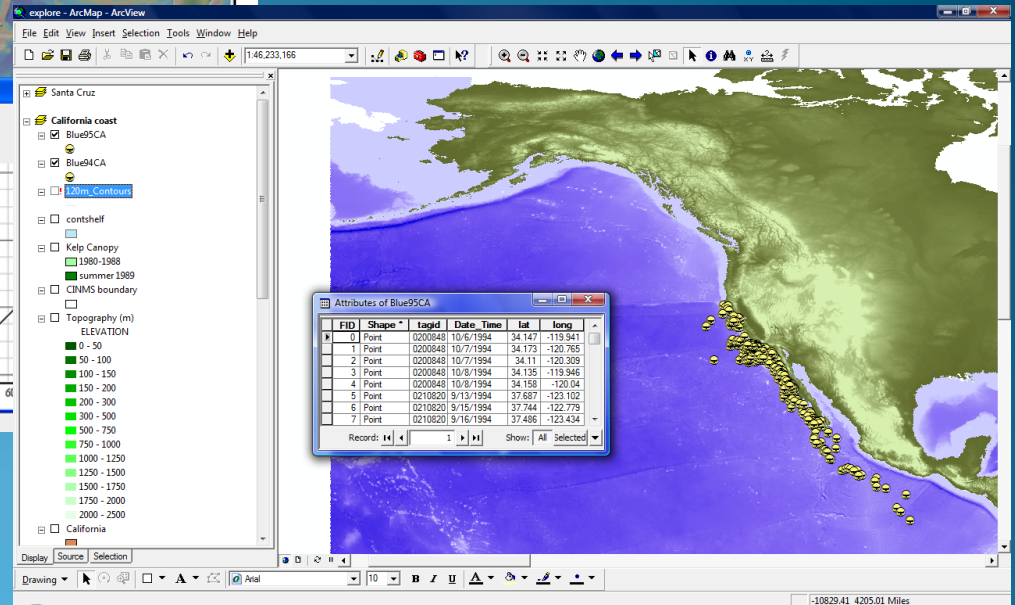
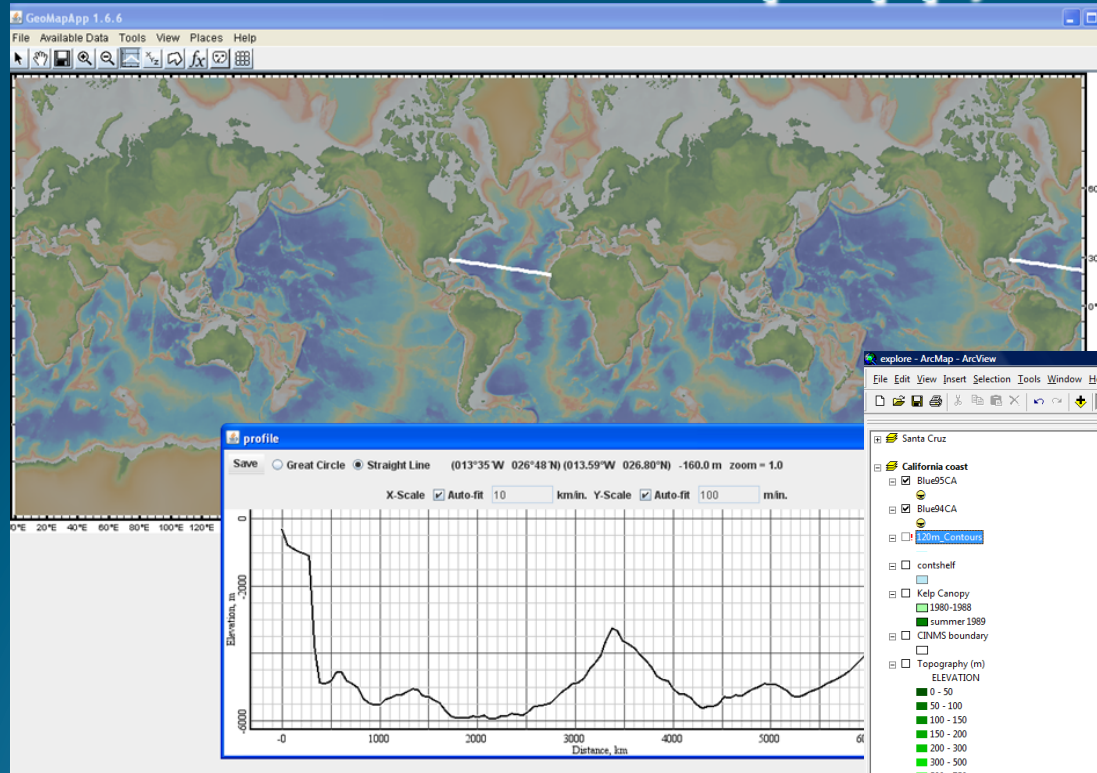
Emily Angerstein, Bryant Beck, Brandon Belgard, Payton Bowman,
Donald Forbes, Antonio Garibay, Whitney Grisson, Christopher Jackson-Grady,
Ricky Jones, Rory McKinnon, KC Pisu, Christopher Rath, Dylan Robinson, Jared Smith,
Alicia Stoffel-Jamison, Lionel Wilson, Brian Wake (Teacher), Erin Marie Nicholson (Assistant)

Oregon NAD 27 Projection
1:40,000

Case Study; Digital Mapping

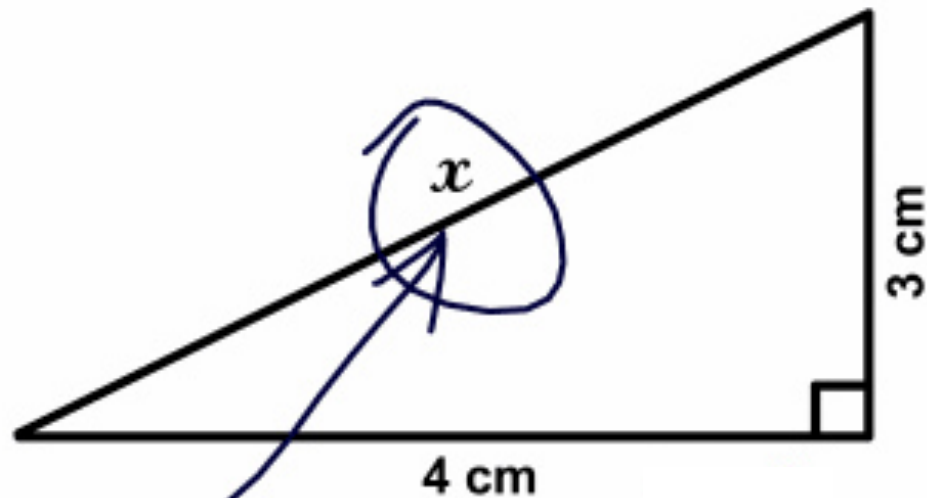
4 Classroom Sessions,

GeoMapApp, ArcGIS



Defining Spatial Thinking

3. Find x .



Here it is

Spatial Thinking

8 Neurologically Distinct Modes

Comparison

Transition

Aura

Analogy

Region

Pattern

Heirarchy

Association



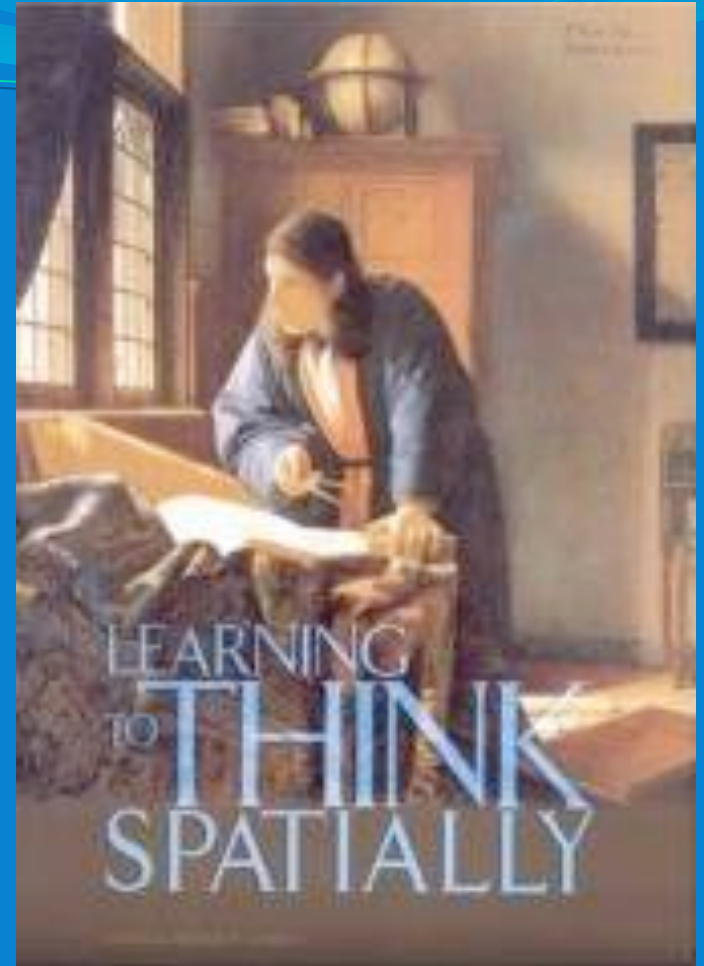
(Gersmehl and Gersmehl, 2007)

Defining Spatial Thinking

Amalgam of 3 elements

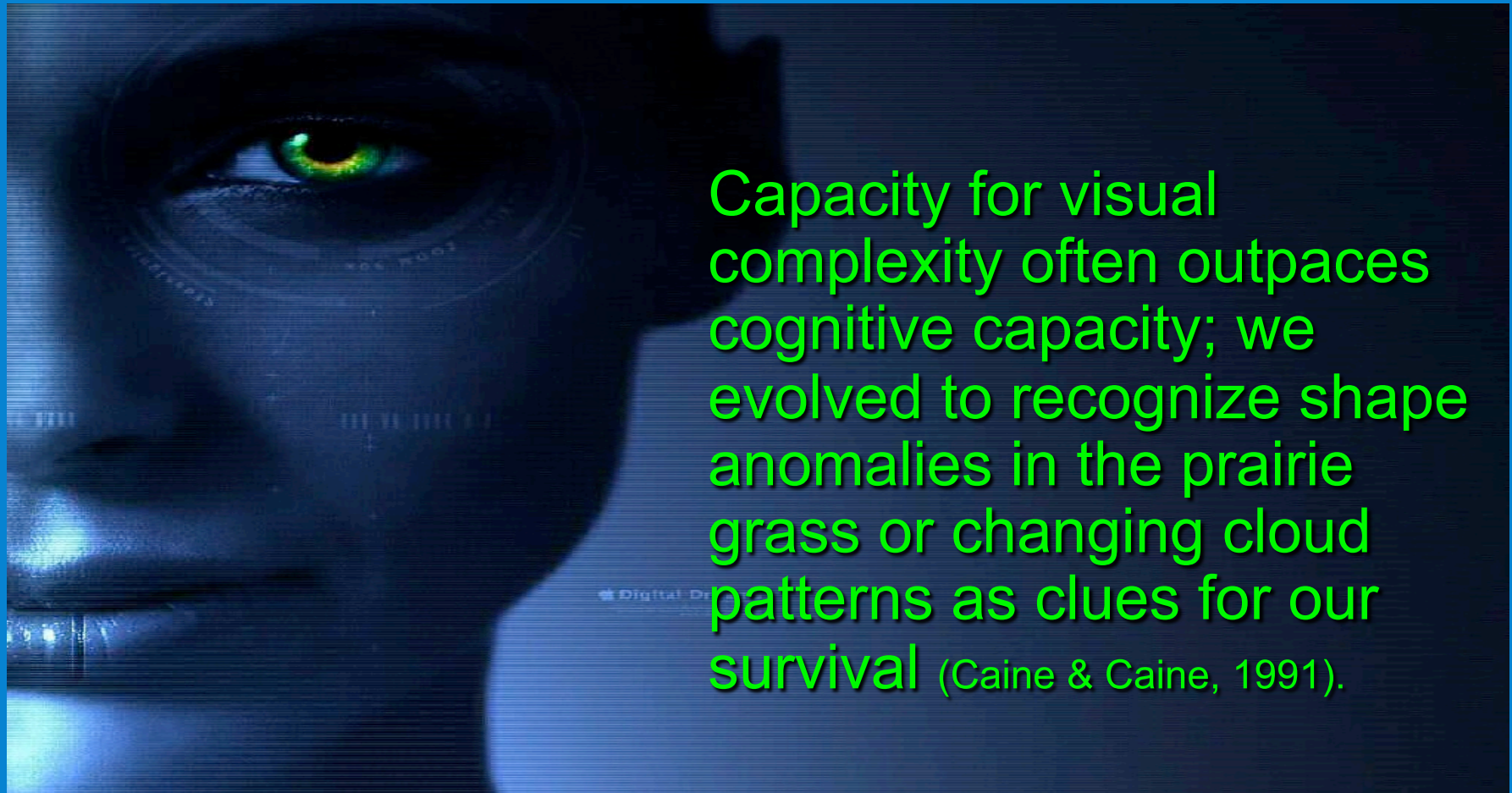
1. Concepts of space, habit of mind
2. Tools of representation
3. Process of reasoning
(problem solving)

My idea was that using geovisualizations (tools of representation) would help students develop the skills that would enable them to use processes of reasoning and observe patterns, associations and spatial order.



National Research Council, 2006

Pattern Recognition



Capacity for visual complexity often outpaces cognitive capacity; we evolved to recognize shape anomalies in the prairie grass or changing cloud patterns as clues for our survival (Caine & Caine, 1991).

A photograph of a brown seal resting on a sandy beach. The seal is lying down with its head on the sand, eyes closed, and appears to be asleep. A large, yellow thought bubble with a blue outline is positioned above the seal's head. Inside the bubble, the text "Zzzzzzzzzzz!! Wake me when she's done" is written in a black, italicized font. The background shows the sandy beach and some dark, wet sand patches.

***Zzzzzzzzzzz!! Wake me
when she's done***

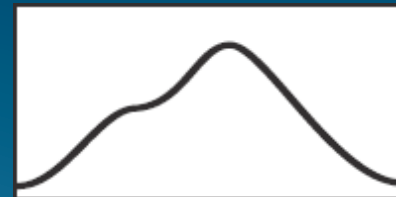
Case Study; Corvallis High School Assessment

- 28 questions
 - Open Ended
 - Map Interpretation
 - Matching
 - Graph/Image Interpretation
- 45 minutes, no resources
- Designed to measure changes in spatial thinking

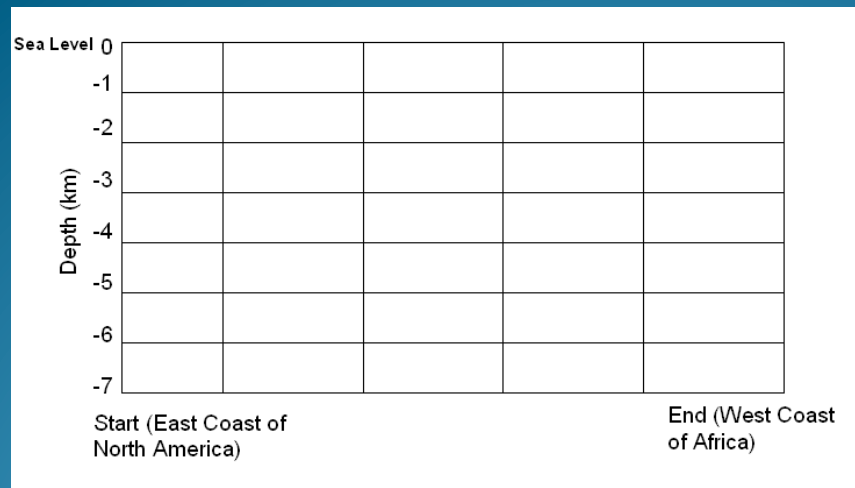
Case Study; Corvallis High School

Assessment

Open Ended Question



If this is a profile view of a bathtub, and this is a profile of a mountain range:

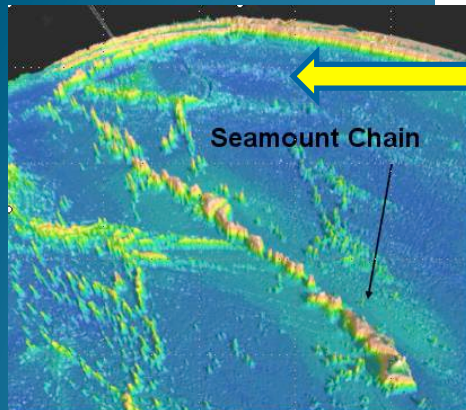
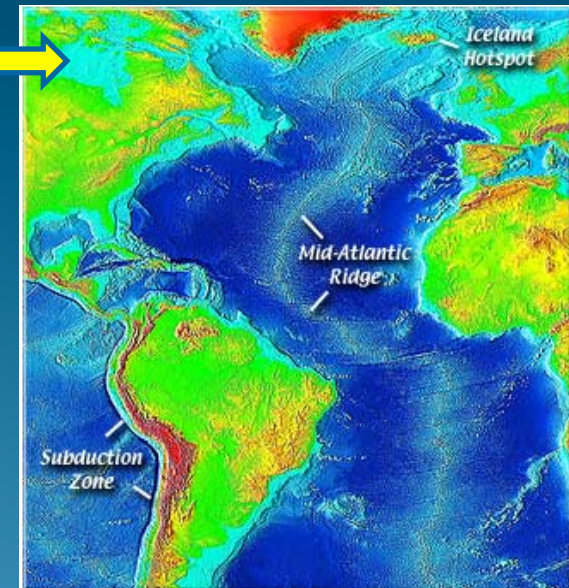
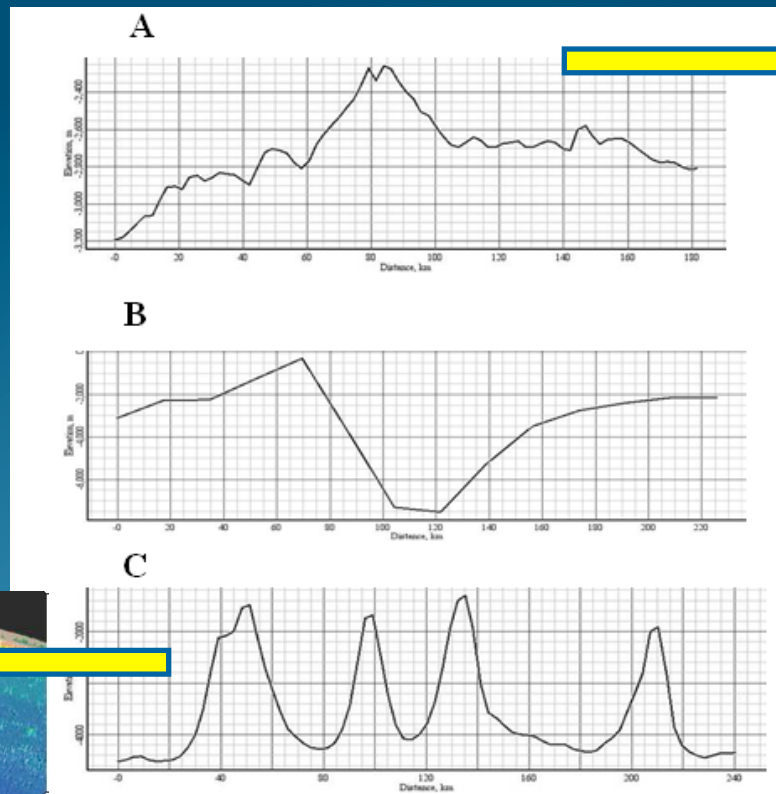


sketch what you *think* a *profile of the seafloor* looks like across the *Atlantic Ocean* along a ships path from *East Coast of North America* to *West Coast of Africa*.

Case Study; Corvallis High School

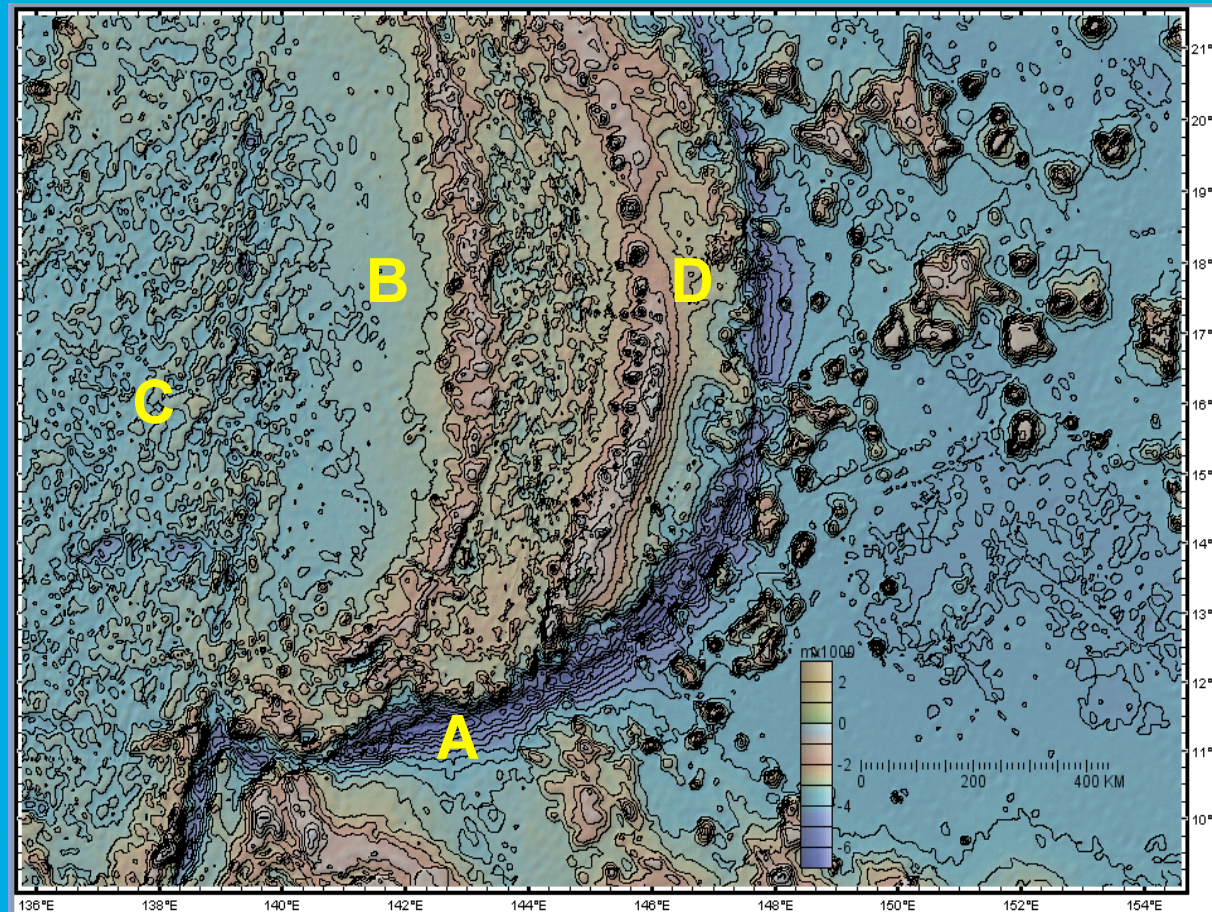
Assessment

Graph Interpretation



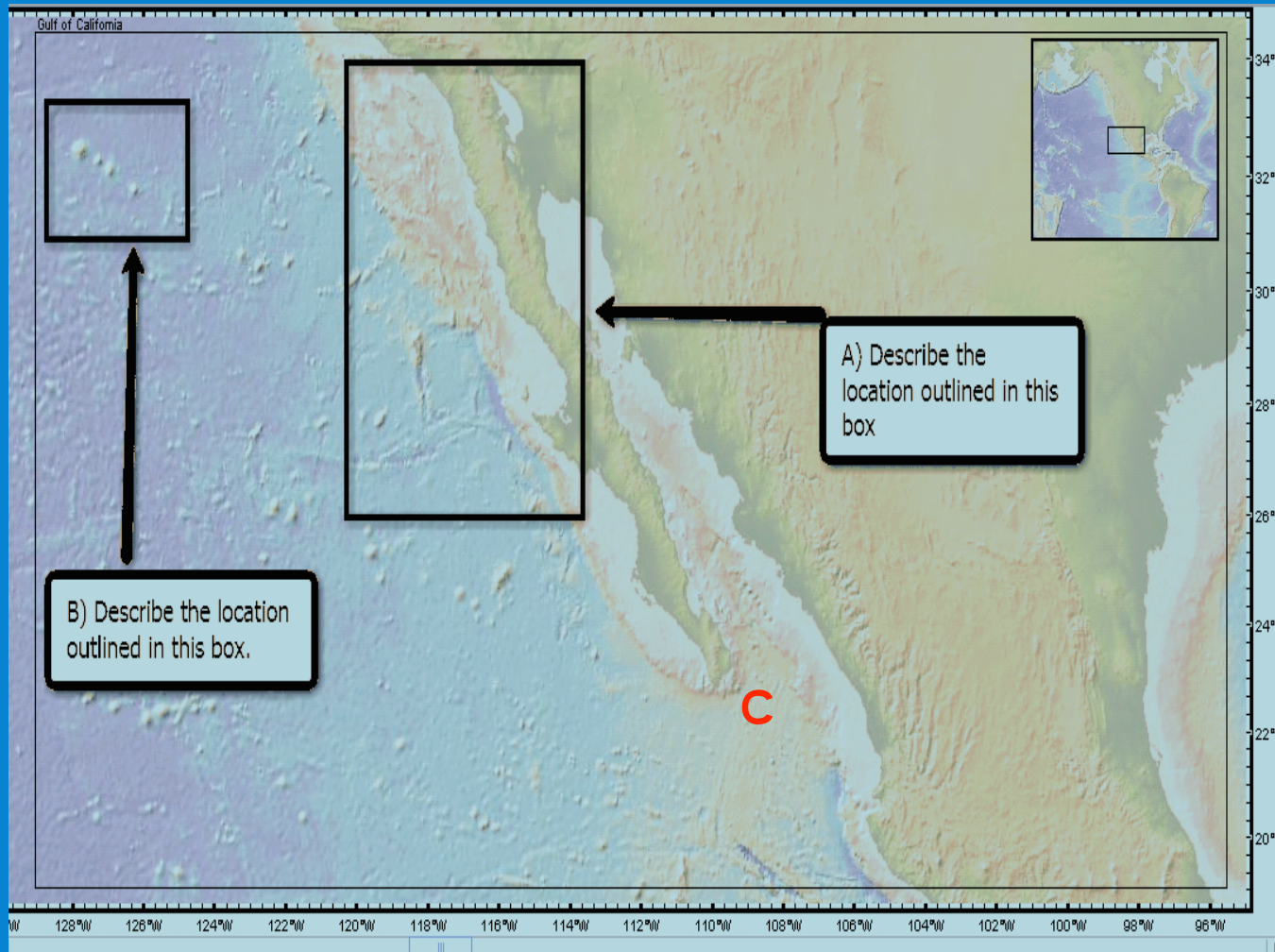
Assessing Spatial Thinking

Pattern Recognition, Comparison



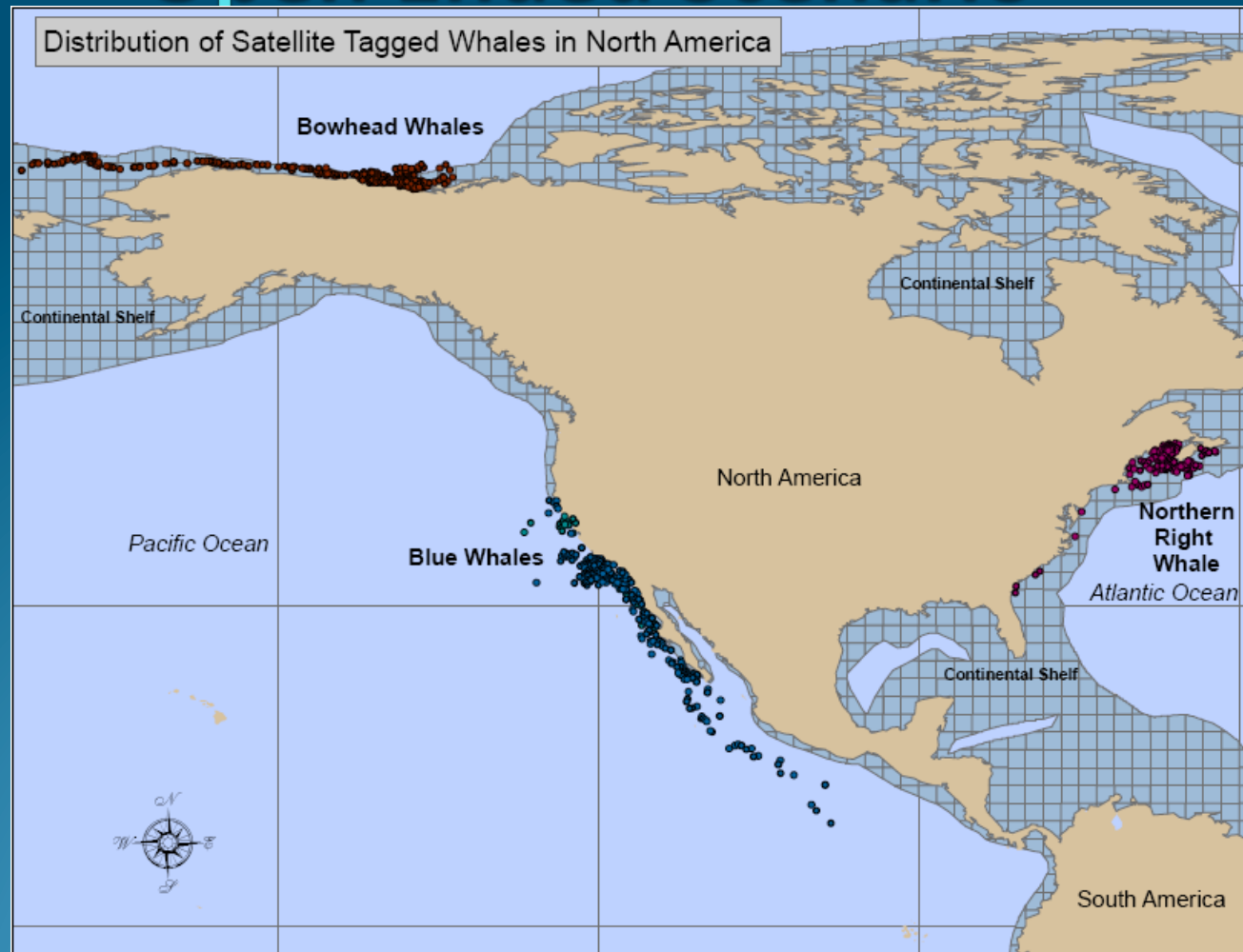
Pre and Post Assessment Questions 10-12.

Open ended, map interpretation questions



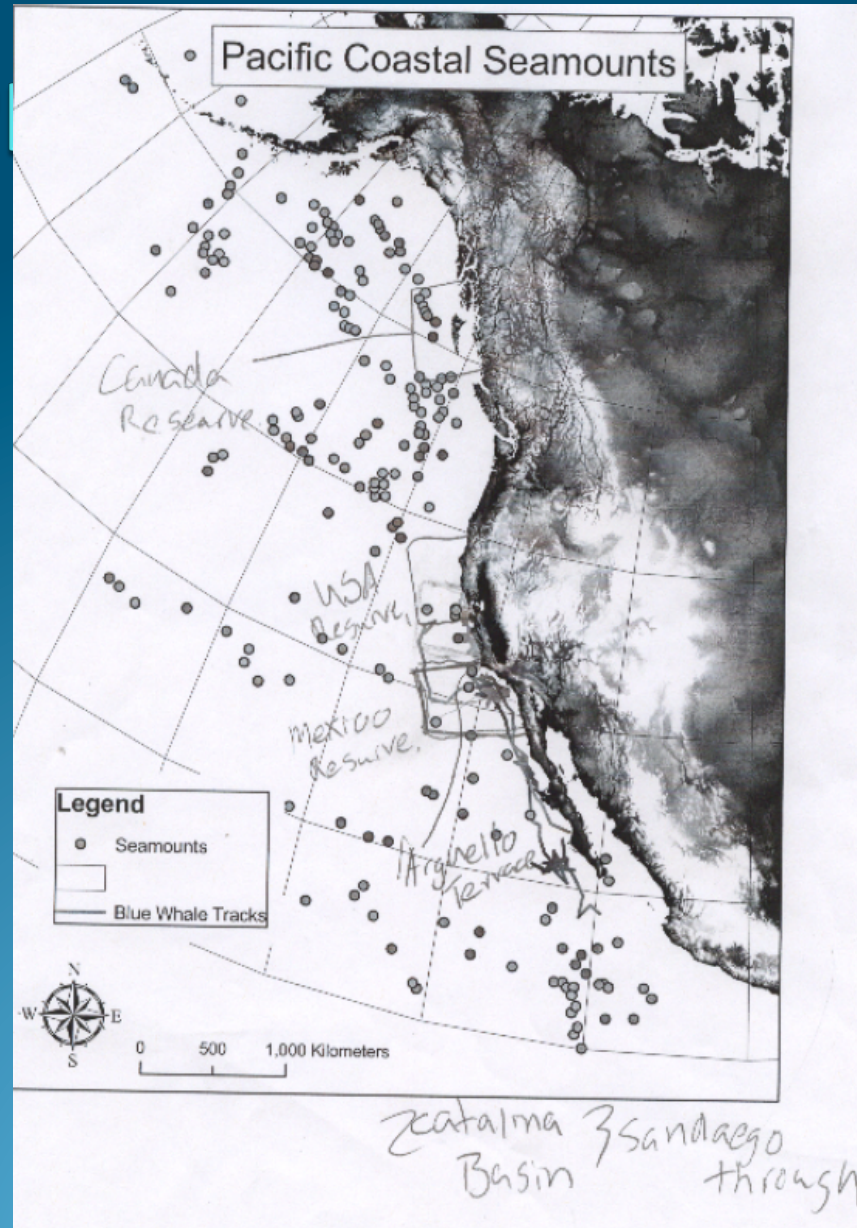
Case Study; Corvallis High School Assessment

Open Ended Scenario



Assessment

O



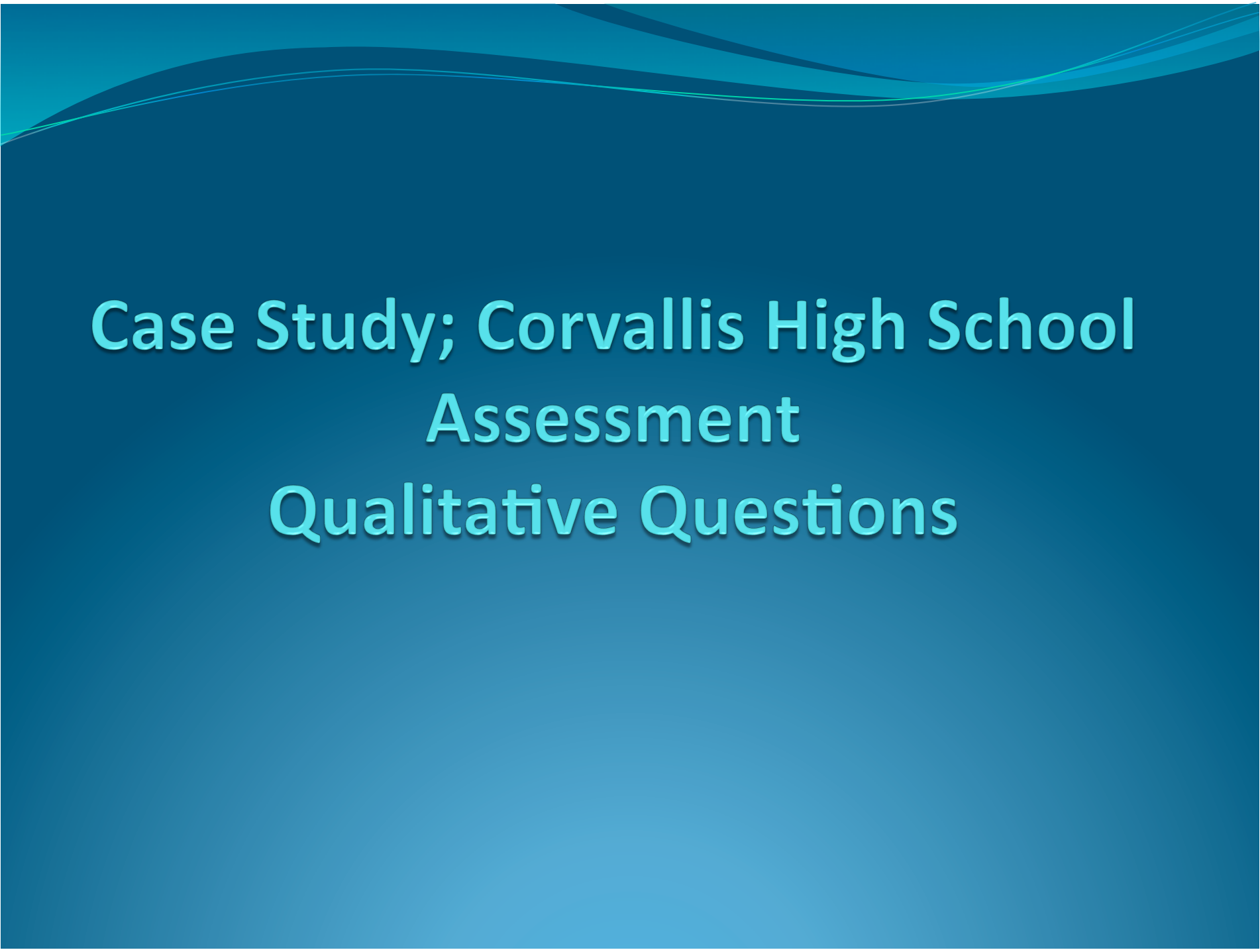
Case Study; Corvallis High School Assessment

Quantitative Questions

Scored and Statistically Analyzed

Question Number <i>Pedagogical Skill Set</i>	PRE ASSESSMENT	POST ASSESSMENT	Change in Mean Scores	Student t- test paired means df= 26
2. Estimate Slope of Seafloor <i>Math and Map Interpretation*</i>	0.296 ± 0.465	0.444 ± 0.934	0.222 ± 1.086	t = -2.209, p-value = 0.0362
3-9. Profile Across Atlantic Ocean <i>Graph Interpretation†</i>	2.481 ± 1.55	2.593 ± 1.67	0.444 ± 0.641	t = -0.9208, p-value = 0.3656
13-15. Seafloor Bathymetry Visual Graphic <i>Map Interpretation*</i>	1.480 ± 0.802	1.926 ± 0.829	0.444 ± 0.641	t = -2.209, p-value = 0.0362
16-18. 2D → 3D <i>Object Representation, Spatial Thinking</i>	2.000 ± 1.359	2.111 ± 1.22	0.111 ± 1.396	t = -0.4136, p-value = 0.6826
20-23. GeoMapApp Profiles <i>Graph Interpretation†</i>	1.667 ± 1.664	1.889 ± 1.423	0.222 ± 1.188	t = -0.9208, p-value = 0.3656

Question Number <i>Pedagogical Skill Set</i>	PRE ASSESSMENT	POST ASSESSMENT	Change in Mean Scores	Student t- test paired means df= 26
All Quantitative Questions, Combined Scores	7.815 ± 4.077	8.778 ± 4.326	0.963 ± 3.107	t = 1.6105, df = 26 p value = 0.1194
All Quantitative Questions, Combined Scores, Females vs. Males	t = -0.7997, df = 26, p-value = 0.4311	t = 0.0211, df = 26, p-value = 0.9833		



Case Study; Corvallis High School Assessment Qualitative Questions

Map Interpretation

Categories of Spatial Thinking

Spatial Thinking Modes

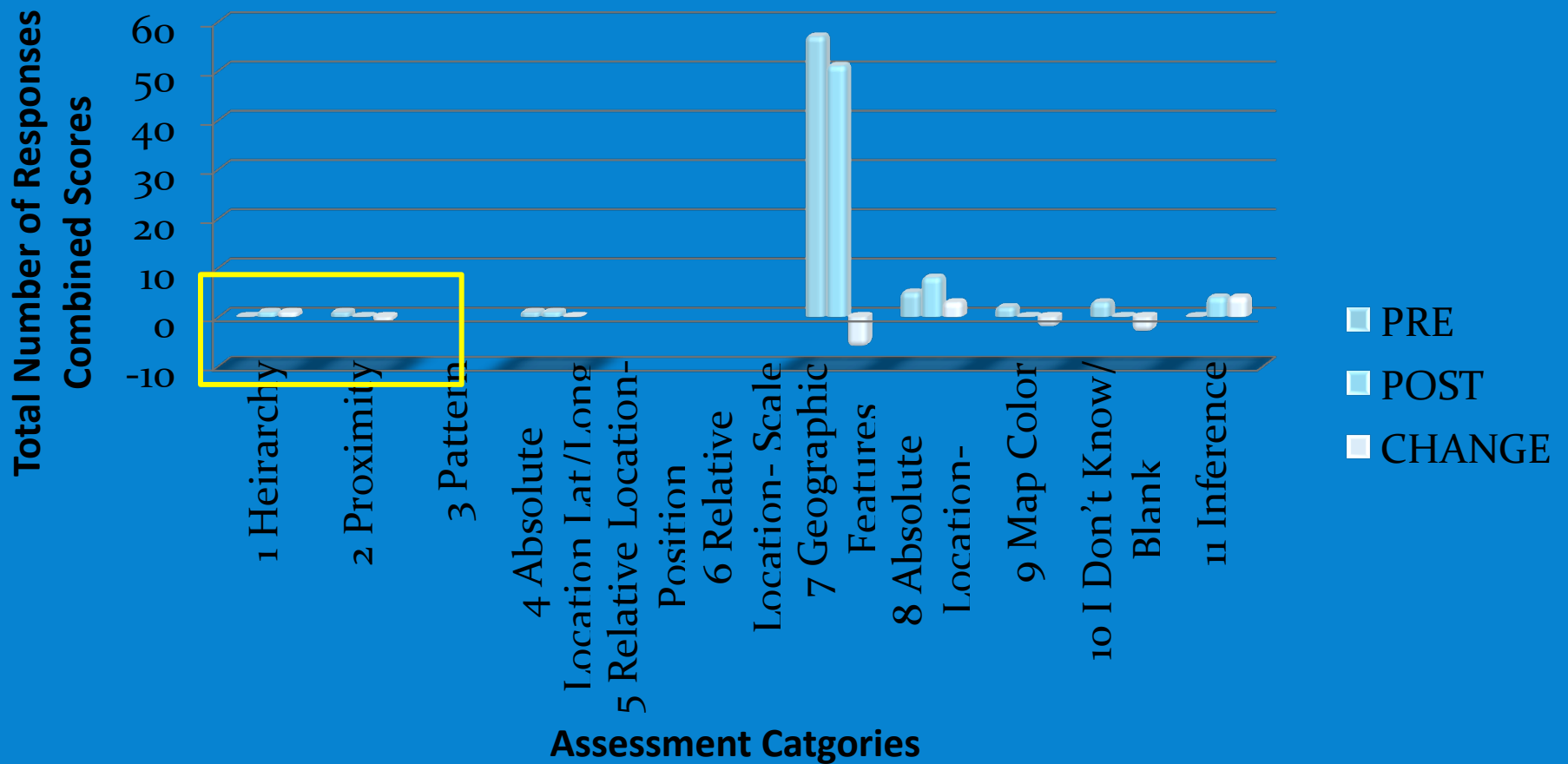
- 1) Hierarchy; nested areas of different sizes
- 2) Proximity; Location is close to...
- 3) Pattern; Non random arrangement of geographic features

Geographic Description

- 4) Absolute Location – Latitude/Longitude values
- 5) Relative Location – Map Position; 2 inches left of Baja California Coast
- 6) Relative Location – General Scaling; $\frac{1}{2}$ way from top of map
- 7) Geographic Features; coast, shoreline, land, water, seamount, mountain, etc.
- 8) Absolute Location - Geographic Names Other
- 9) Map Color
- 10) I Don't Know/Blank
- 11) Inference; blue whale habitat or reserve

Results – Qualitative Questions

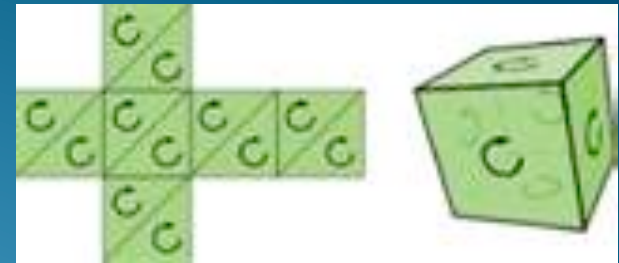
Question 10-12 - Map Interpretation of Outlined Area



Assessment

Challenges:

- Tease out thinking modes without limiting students with concepts or vocabulary
- To “test” in a non-traditional manner
- Eliminate advantages for those with high reading or math skills
- Tests are largely a matter of vocabulary
 - What you ask
 - How you ask it
 - Familiar terminology or concepts



Results

1)What advantages are there to using an interactive, immersive geovisualization in the design and implementation of curriculum at the high school level?

- Deeper levels of understanding
- Higher levels of comprehension of oceanographic and geographic principles

Results

2) How can multimedia technologies best be utilized in aiding students to achieve the educational standards related to geography, science and technology?

- Stimulate interest
- Allow for development of higher order skills
- Use of real world data sets and cutting edge technologies
- Best used in multidisciplinary, inquiry based lessons

Results

3) What pedagogical issues in secondary school curriculum development can be addressed with the use of interactive, immersive geovisualizations?

- Address demands of standards based testing
- Incorporate digital technology training into existing curricula
- Reach multiple learning modalities, reward digital learners

Results

4) How does the use of real world scientific data sets enhance educational practices?

- Acquisition and utilization of geographic information
- Improved spatial thinking skills
- Ability to evaluate information and make judgements (Bloom's Taxonomy – highest level)

Case Study; Corvallis High School

Challenges to Using Tools

...Why isn't everyone using them?

- Lesson Preparation
- Technological Logistics
- Assessments; inventing the wheel
- Time and Cost Intensive

Using Geovisualizations

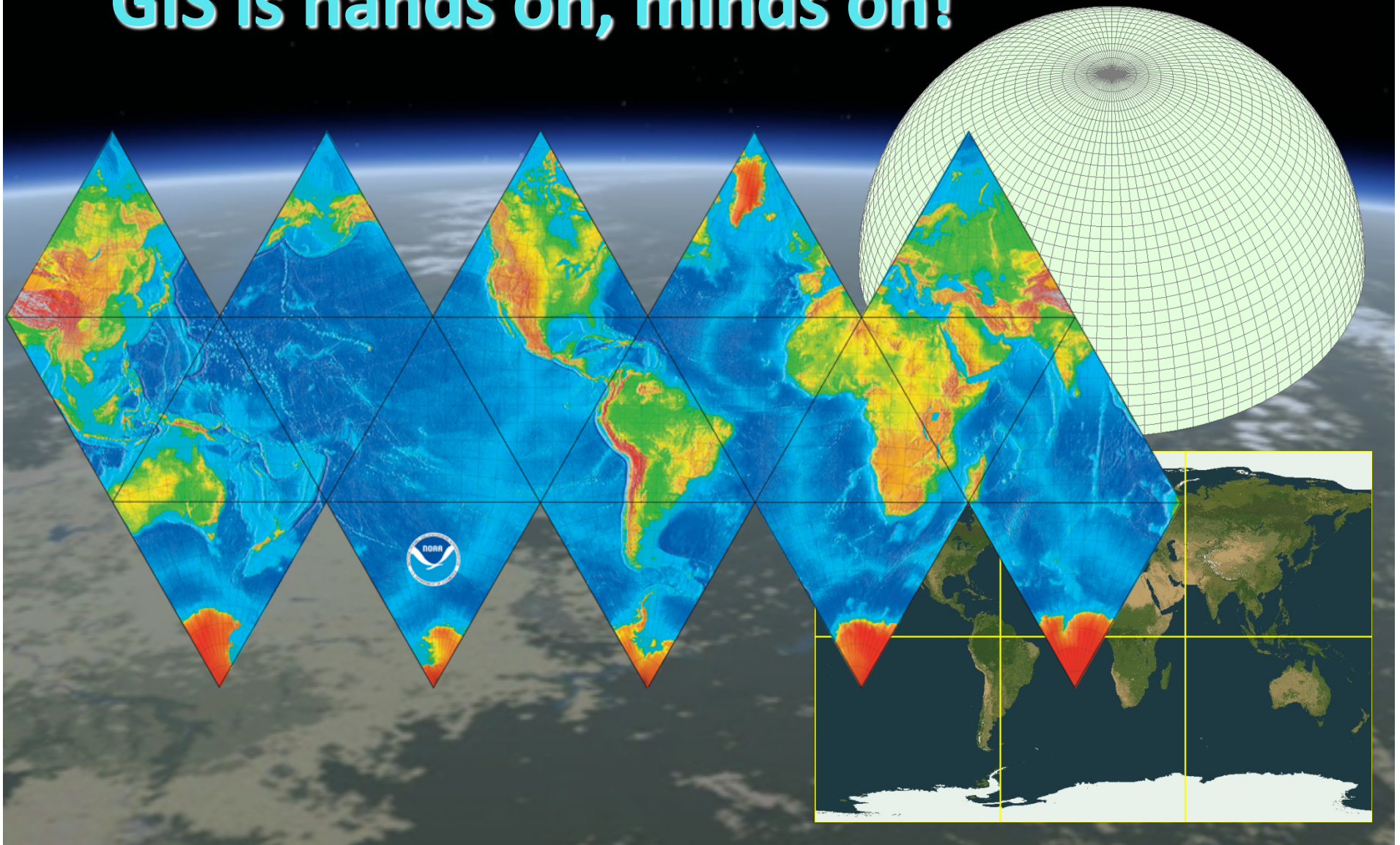
- Our society has changed
 - ...Digital Technology is part of our culture
- Our educational systems and teaching methods need to update
 - ...Digital should be the 'New Traditional'

Using Geovisualizations

- Success in the new millennium has been reframed
 -Our students need new skills for our technological paradigms
- It is time for our schools and teaching to match these changes!

Tools of Exploration and Discovery

GIS is hands on, minds on!



Questions??

Thank You for your time and attention!♪



In later life, as in earlier, only a few persons influence the formation of our character; the multitude pass us by like a distant army.





Is she done
yet?

Yep, let's
get some
more cake!

