A framework for beginning to think about differentiating options for age-appropriate geospatial instruction

SITE Conference Panel 2012
Developing a Curricular Sequence for K-16 Geospatial Integration

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Two curriculum and professional development projects

- Studying Topography, Orographic Rainfall, and Ecosystems with Geospatial Information Technology (STORE)
- DICCE Data-enhanced Investigations for Climate Change Education (DICCE)

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Acknowledgment: Funding for the Studying Topography, Orographic Rainfall, and Ecosystems with Geospatial Information Technology Project is provided by National Science Foundation DRL Grant 1019645
OR, in other words, how do we keep our students (and ourselves) from getting lost in the forest?

...then hand it in and study for the recall test

Image retrieved 2-28-12 from http://www.flickr.com/photos/jptournut/5370854086/
What kind of framework can help us improve on what we already try to do, as difficult as that is?
STORE (Studying topography, orographic rainfall, and ecosystems with geospatial information technology)
STORE Google Earth master data of mid-California “study area”
DICCE Project
(Data-enhanced Investigations for Climate Change Education)

Looking for evidence of climate change in New Mexico

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Images</th>
<th>Time Range</th>
<th>Shows Trend</th>
<th>Explain Your Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow cover</td>
<td></td>
<td>1979-2011</td>
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<td>Carbon dioxide</td>
<td>2003-2011</td>
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<td>Greenness</td>
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<td>2002-2011</td>
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<tr>
<td>Rainfall</td>
<td></td>
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</table>

Help Tools Available

Plotting Sea Surface Temperatures 08-09

Directions
As you look at the sea surface temperature maps please develop a graph of each month: Dec-Jan, Feb-Mar. Then draw a straight line transect from A, Hawaii straight eastward b. About 3cm above previous transect c, another 3 cm above previous transect. Now take the data for each color change and plot it out on a graph with Temperature being the "y" axis and longitude being the "x" axis for each month.

Questions

1. What is the area of significant change from Dec 2008 to January 2009?
2. What do think caused this change?
3. What effect(s) do you think this caused on the weather?
4. What effect(s) do you think this may have caused to sea life or those whose employment depended upon sea life?
Leveraging the principles of…

• Backward instructional design (Wiggins and McTighe)
  – Start with desired enduring understandings, then work backward to develop the curriculum

• Evidence-centered assessment design (Mislevy and colleagues)
  – Model the targeted knowledge and skill domains in terms of student cognition, then design tasks to validly assess the student’s acquisition of them
STORE understandings about climate

1. How different factors influence the dynamic responses of ecosystems to climate change (e.g., length of time for a species to adapt, minimal viable size for an ecosystem area, migration rates, interdependencies of species).

2. How anthropogenic impacts on the environment interact with climate change to exacerbate its effects.
Layers in evidence-centered design of assessments

**Domain Analysis**
- What is important about this domain?
- What work and situations are central in this domain?
- What KRs are central to this domain?

**Domain Modeling**
- How do we represent key aspects of the domain in terms of assessment argument. *Conceptualization.*

**Conceptual Assessment Framework**

**Assessment Implementation**

**Assessment Delivery**
- Students interact with tasks, performances evaluated, feedback created. *Four-process delivery architecture.*

Leveraging ECD to differentiate age-appropriate learning goals and tasks

Reasoning with data using a GIS

- Active learning tasks
- Create visualizations
- Analyze visualizations
- Express reasoning verbally
- Express reasoning with visualizations
STORE Skills

1. Interpreting geospatial data
2. Drawing appropriate geographical conclusions from geospatially-referenced evidence
3. Applying algorithmic relationships between weather factors to geospatial data analyses
4. Manipulating inputs into climate change models to project different climate change impacts on the ecosystem – *in progress*
Leveraging ECD to differentiate age-appropriate learning goals and tasks

Reasoning with data using a GIS

Understanding particular GIS symbology in order to interpret maps that contain those symbols

Ability to look for relationships over space and time between specific variables
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Extent to which the symbols on the map are contextualized

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Types of data distributions and variables
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Assess
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Student content knowledge/enduring understandings *

Provide Feedback

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STORE understandings about climate change models

1. How climate change models rely on conjectures about future greenhouse gas emissions, based on human population changes and economic activity to make projections about the magnitude of climate changes.

2. How climate change models account for the interdependence of temperature and precipitation.
STORE understandings about using data to study climate and model climate change

1. How the following characteristics of data collected by scientists to analyze climate influence conclusions
   - the data's resolution/granularity
   - where, how, and how often the data are collected
   - the representativeness of a single "point" measurement for a given area
   - data calibration and data quality

2. How the ways in which geo-spatial phenomena are summarized in statistical analyses (e.g., means, minimums and maximums, distributions) affect what conclusions are viable

3. That there are constraints in using global climate change models to predict local and regional changes, which are primarily due to limitations on the resolution and representativeness of the available data.
Problem types (Jonassen)

Most well-structured

• Logical problems (manipulating limited variables)
• Algorithmic problems (applying algorithms to similar sets of variables)
• Story problems (applying algorithms in a story context)
• Rule using problems (applying specific rules to solving problems with one correct solution or goal yet multiple possible paths to the solution)
• Decision-making problems (determining an optimal response to complex yet consensually-agreed upon problems)
• Troubleshooting problems (diagnosing what went wrong and how to fix it)
• Strategic performance problems (performing complex tasks in real time that require tactical maneuvering)
• Case analysis problems (solving ill-defined problems in the face of ill-defined goals and constraints)
• Design problems (designing products or services with ill-defined goals and solution paths that require mastery of multiple knowledge domains)
• Dilemmas (trying to solve problems when compromises are implicit in every solution yet none is likely to be acceptable to everybody)

Problem types (adapted to geospatial learning tasks)

Most well-structured

• Logical problems (manipulating or analyzing limited geospatial variables)
• Algorithmic problems (applying a formal geospatial analysis procedure to similar sets of variables)
• Story problems (applying analytic procedures to solve a geospatially-situated problem conveyed in a story)
• Rule using problems (for example, formulate a predictive model of a geospatially-situated set of outcomes)
• Decision-making problems (using geospatial data to determine the best spots for wetland restoration along a particular river)
• Troubleshooting problems (for example, diagnosing what went wrong with a query or analysis and how to fix it)
• Strategic performance problems (performing geospatial data collection tasks in real time that require tactical maneuvering)
• Case analysis problems (for example, determining an appropriate geospatial data collection regimen and analysis for evaluating the outcomes of an environmental restoration effort)
• Design problems (designing a GIS application or data viewer interface through a user needs analysis)

Most ill-structured

• Dilemmas (for example, using geospatial data to determine the best zoning scheme for a particular community or Congressional district redrawing)
## Problem types and STORE project tasks

<table>
<thead>
<tr>
<th>Problem types</th>
<th>Examples of STORE Project lesson tasks (concerning a particular geographic region)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most well-structured</td>
<td></td>
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<tr>
<td>Logical problems</td>
<td>Ascertaining relationships between topography, temperature, air pressure, relative humidity, and precipitation</td>
</tr>
<tr>
<td>Algorithmic problems</td>
<td>Calculating dew point from certain numeric inputs (for example: If the relative humidity is 90% at a noon-time temperature of 75°F (297°K), at what temperature will dew form that night?)</td>
</tr>
<tr>
<td>Story problems</td>
<td>Determining the atmospheric temperature lapse rate through knowledge of differences between elevation and average ground-level air temperature at two weather stations</td>
</tr>
<tr>
<td>Rule using problems</td>
<td></td>
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<tr>
<td>Decision-making problems</td>
<td>Apply knowledge of elevation ranges of four types of vegetation communities in order to identify a type that is likely to have a shrinking habitat in the region if global warming predictions come true, and explain why. Use prior analyses to determine if temperature or precipitation will have a greater influence on vegetation in the region in 2050.</td>
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<tr>
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<td>Apply knowledge about what makes some species more adaptable than others to identify an individual species within the region that is relatively more likely to be able to adapt successfully to projected climate change by 2050.</td>
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<td>Dilemmas</td>
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Backward Mapping Approach

Connect to content knowledge/enduring understandings*
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