Building teacher capacity for teaching about climate change with geospatial data and visualization technology

Brief Paper
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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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Powerful data and visualizations are nice to have, but what about…

- Pedagogy?
- Learning goals?
- Learning supports?
- Uses of technology?
- Assessment?
- Feedback to students?
Focus of presentation

• Making choices evident
• Using different strategies to help teachers make those choices
Choices about pedagogy

Didactic → Constructivist

Scripted → Exploratory

Topic-based → Problem-based

Reifying with data → Building meaning from data
Choices about learning goals

- Software manipulation skills?
- Scientific practice skills?
- Scientific knowledge?
- Data literacy?
Choices about learning supports

- Technical directions?
- Glossary help?
- Data interpretation help?
- Transparency concerning data and data collection methods?


Choices about student uses of technology

Study images

Interact with image-producing software (query, create layers, annotate)
Choices about assessment

- Requiring student use of technology to complete the assessment?
- Embedded or summative?
- Designed for convergent or divergent thinking?
- Selected-response or constructed response?
- Requiring transfer of learning to new contexts?
Choices about feedback
(there’s often not enough of it*)

• How will students know when they’ve learned something?
• How will students know when they’ve done something right?

Strategy options

• Provide curricula? (Schneider et al., 2005)

• Make potpourri of resources available and let the teachers decide which to use?

STORE and DICCE
Common strategies

• Students look for climate change trends in geospatial Earth System data layers from weather stations, satellites, and models in relation to global trends.
• Students examine the data to (1) reify what they are learning in science class about meteorology, climate, and ecology, (2) build inquiry skills by posing and seeking answers to research questions, and (3) build data literacy skills through experience generating appropriate data queries and examining data output on different forms of geospatial representations such as maps, elevation profiles, and time series plots.
STORE and DICCE
Common assumptions

• Students will be more engaged and able to utilize prior knowledge better when seeing the local and hence personal relevance of climate change and related pressing contemporary science issues.

• By providing a scaffolded technology-supported process for instructional design around geospatial data, teachers will make better instructional decisions.

• Geospatial data visualization technologies can be powerful learning tools yet their uses are constrained by challenges that teachers and students encounter navigating data access, making sense of data characteristics, understanding needlessly difficult nomenclature, and being deprived of important details about the data that help the learner understand their significance with respect to the focal Earth system phenomena.
The Primary Difference

Teacher capacity-building through face-to-face co-design among core teacher group and mentoring of other teachers (STORE) vs. through online system of data querying and supported curriculum construction (DICCE)
STORE Technology

- Give students empty GIS application and have them import, query, and configure data for interactive analysis --OR--
- Give students GIS application filled with data and have them analyze it
- Interacting with the application: drawing polygons, annotating layers, computing areas, creating transects, studying elevation profiles, conducting flyovers, doing queries
STORE technology (cont.)
ARC GIS Explorer interface
Students compare average temperatures and annual precipitation totals along a transect of different weather stations at different elevations in order to see the orographic effect in action.
Adaptations of STORE Original Lesson 2 by New York teachers for New York State (NYS) data

- Students asked to sketch on paper a graph showing the relationship between elevation and temperature?
- The explicitness of this task: Describe the general pattern of temperatures in New York State (NYS) along an East/West Line that goes through Syracuse" as opposed to too-vague questions like "Describe the data"
- Students prompted to think about whether there would be trends if you are looking at a strictly north-south or east-west transect (which helps students to discover themselves that longitude or latitude is not by itself an indicator of such trends in a small region like NYS.
- Students asked: The relationship between temperature and elevation is seldom perfect across specific areas of NYS. What other variables might impact the patterns that you observed? Where do they occur?"
Teacher peer review of each other’s adaptations

Example

California teachers praise the explicitness of a NYS teacher’s map analysis prompt: “Describe the general pattern of temperatures in New York State (NYS) along an East/West Line that goes through Syracuse" as an improvement over questions like "Describe the data" and “What do the data look like?”
Some teachers opt to create new lessons
Example:
Extending the inquiry to animal species

- The following is a list of special-status land animals in California. These animals are listed as endangered or sensitive, and they may be sensitive to climate change. Your job is to look at the geographic area you are studying (the STORE California Study Area), find one of these animals that inhabits your expertise area (land-cover range) within the study area, and make an educated guess on how the animal might be affected by the shift in range you've predicted in the last lab.
- Present your research and your hypothesis in 3-4 slides, and include images of the animal.
- Create a Google Earth image of the current and predicted ranges of your animal in 2050 and 2099, and be prepared to answer questions on how you arrived at this prediction.
- Make notes on the above research, then discuss and formulate a hypothesis on how the animal will react and adapt to the climate change and land cover change you've predicted.
Students analyze projected ranges of vegetation types in 2050 in relation to projected temperatures and precipitation amounts.
Teacher-developed extension lesson (cont.)

Some information to include in your investigation:

- Current range of the animal
- Relationship of the animal to the plant community it inhabits (symbiosis?)
- The animals' eating and sleeping habits (will its diet be effected by a shift in plant range?)
- The animals' temperature and moisture comfort range and adaptability
- The animals' breeding cycle and habits around rearing young (are these based in any way on temperature, precipitation, and surrounding vegetation?)
- Any anecdotal information unique to the animal that is predictive of its ability to react to climate change (i.e. if the animal lays eggs in shallow puddles, it can't live with a significant reduction in rainfall).
DICCE Structure

Figure 1. DICCE Classroom Project Development Process

DICCE - Giovanni
Education specific capabilities
- Visualizations
- Datasets
- Expanded guidance

DICCE - Learning Environment
- Project templates
- Learning supports (e.g., glossary, inquiry tips)
- Customized datasets
- Linkage to Google Earth
- Student activity prompts
- Rubrics

NASA remotely sensed data

Google Earth

Other data sources
DICCE Technology

- Have the teacher query large data portal for images
DICCE Technology

• Give students images to analyze, in teacher-authored lessons
• Provide item bank from which to choose aligned near transfer tasks for assessment purposes (in progress)
DICCE Technology

Provide additional supports for the teacher to make available to the students