Building Local Geospatial Inquiries for Your Students Using ArcGIS Online

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Socio-Environmental Science Investigations (SESI)

- Inquiry-based investigations
- Map-based mobile data collection
- Analysis with Web-based mapping software
- Pedagogical frameworks of place-based education and socio-scientific investigations
- Local issues
- Field work in the local setting
Our Project

First ITEST project: *Socio-Environmental Science Investigations (SESI)*...

- One university (Lehigh) working with one local high school
- Integrating geospatial tools into science & social studies classes
- Intended outcomes:
  - Teacher knowledge, integration of geospatial tools into curriculum-aligned instruction
  - Student use of geospatial tools →
    - Interest / engagement in STEM-related college and career paths
    - Advances in spatial thinking
    - Preparation for geospatial workforce

Since then: Funded for *SESI-ExpAND*

- Three universities...
- ...working across four states...
- ...with six high schools...
  - Traditional
  - Magnet
  - Alternative
- ...and a wide range of content areas
  - Biology
  - Environmental & Earth Science
  - Social Studies
  - STEM
  - Computer Science
  - (etc.)
Example: Urban Heat Islands

A map of heat exposure and most heat vulnerable census blocks in Philadelphia.
1. Start with a driving question...

How do surface properties affect heat?

(Note: Lots of thermodynamics lurk within this simple question...)
2. Collect data on school property

Equipment used:
- iPad w/ GPS chip (no phone plan needed), [can also use a cell phone]
- Esri Collector app (freely available)
- IR thermometer (~$12/each)
3. Examine data, look for patterns
   a. Visual inspection
3. Examine data, look for patterns

b. Structured analysis

Note: The students we work with need plenty of scaffolding
4. Unpack necessary background info (thermodynamics)
5. Integrate additional data layers for analysis (land cover/surface types)
Let’s review the steps as we come to the most impactful one...

1. Start with a driving question
2. Collect data
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
5. Integrate additional data layers
6. **Propose changes to the community**
6. Propose changes to the community

Student Questions

1. What changes would you make within your selected area to reduce the urban heat island effect without altering land use?
2. If you were allowed to alter land use, what changes would you make within your selected area to reduce the urban heat island effect?
3. How would you change the school’s property to reduce its urban heat island effect?
Student response

Draw polygons to show areas you would change...
Overlay on a satellite image
Changing assumptions conditions

SESI instruction as conceived during precursor grant

1. Start with a driving question
2. Collect [local] data [using school-supplied devices]
3. Examine data, look for patterns
4. Unpack necessary background information
   (thermodynamics)
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Changing assumptions for pandemic learning

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...re-built for pandemic conditions

1. Start with a driving question
2. Collect [at home] data [using personal device]
3. Examine data, look for patterns
4. Unpack necessary background information (thermodynamics)
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Changing assumptions for pandemic learning

**SESI instruction as conceived during precursor**

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**Modified for pandemic conditions**

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Start slow!

Scaffold student (and teacher!) work with GIS, data collection, analysis, etc.
Sample of our current work: Trees & carbon

- **Driving question:** About how much carbon is stored in a tree?
- **Data collection:** Use Survey123 plug-in for ArcGIS & personal device to measure and photograph a tree
- **Examine data...no pattern-seeking. This is an introductory activity and not a full inquiry**
  - Illustrates curricular concept (trees & other plants are one of three major carbon sinks)
  - Allows for practice of process skills (data collection, measurement)
  - Introduces ArcGIS toolset (data collector, GIS, Story Maps)
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Technology used: Suite of tools built around ArcGIS Online

- ArcGIS Collector app
- Survey123
- ArcGIS Online
- Data dashboards
- Story maps
- Data collectors
- Maps, data, analysis tools
- Instructional scaffolds
Sample #2: Macromolecules

- Large molecules, necessary for life, built from smaller organic molecules
- Four classes:
  - Carbohydrates
  - Proteins
  - Lipids
  - Nucleic acids (RNA, DNA)
- Take in through food, and burn off with exercise
Macromolecules as a socio-environmental topic for Biology
Student data collection: Where in my community are macromolecules consumed? Where are they used up?
Student Data: high school gym...a place for exercise
Learning more...
Contextualizing Data

1. Macromolecules as a socio-environmental issue for Biology
2. Student data collection: Where in my community are macromolecules consumed? Where are they used up?
3. Putting this data in context: Student-collected data + external data layers to further explore variables & interactions
Spatial analysis and scaffolding

Look at one layer at a time!

Consider which basemap is most appropriate (visibility, relevant features)
Where are grocery stores?

What is similar about this distribution?

What is different?
Where to work off calories

Clearly a different distribution -- why?
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   a. Spatial thinking: Points & pathways; correlation; density
Spatial thinking constructs...and tools

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3. Putting this data in context: Student-collected data + external data layers to further explore variables & interactions
   a. Spatial thinking: Points & pathways; correlation; density
   b. Geospatial tools to support: Basemaps, clustering
Fast Food: Cluster tool

Cluster tool = greater abstraction...can make pattern more apparent
Grocery Store: Cluster Tool
Why are exercise facilities clustered differently?
Why might patterns exist, and how can we test that using layers?

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   b. Geospatial tools to support: Basemaps, clustering
   c. Hypotheses & testing
Parks & trails?
Income?

Median Household Income in past 12 months (inflation-adjusted dollars to last year of 5-year range):
- > 90,000
- 60,300
- < 30,600

Heart disease prevalence (by county)
Inactivity & Obesity

Census Tract 112.06
The median household income in this area is $104,038.

Median household income by householder age

Zoom to | Get Directions

Delaware FirstMap, Esri, HERE, Garmin, SelfGraph, METI/NASA, USGS, EPA, NPS, ...
How to use data to effect change

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3. Putting this data in context: Student-collected data + external data layers to further explore variables & interactions
   a. Spatial thinking: Points & pathways; correlation; density
   b. Geospatial tools to support: Basemaps, clustering
   c. Hypotheses & testing

4. Decision-making: How to balance using & consuming macromolecules in my county?
Want to learn more about our work?

Precursor grant (including full materials)

https://eli.lehigh.edu/sesi

Current grant (info on partners; will show working versions of materials)

https://sites.google.com/lehigh.edu/sesi-expand/welcome
Want to do this on your own?

Create a (free!) school account

Schools Mapping Software Bundle

The ArcGIS for Schools Bundle is available at no cost for instructional use to individual US K-12 school districts, and states direct from Esri. Beyond the United States, the bundle is available to schools worldwide through Esri’s network of international distributors. Every public, private, home school, and youth-serving club is eligible. For clubs and homeschools requesting software, see GIS Club Kit.

See if your school already has a license.

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Learn how to use ArcGIS!

Esri GeolInquiries

Learn.ArcGIS.com

Esri K12 GIS Organization
Acknowledgements

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Comments and Questions

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