Teaching GIS in a STEM Curriculum

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Objectives:

- Give an idea of how GIS can fit into a STEM curriculum by examining Common Core Standards, Geography Standards, and STEM specific Standards
- Provide information on how to set up a school account and get started with GIS
- Give an idea of how GIS can be incorporated into a STEM Curriculum as a stand alone course or through an integrative approach

Unpacking the Standards – Common Core

- CCSS.ELA-LITERACY.RH.9-10.7
  Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
- CCSS.ELA-LITERACY.RH.11-12.7
  Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
- CCSS.ELA-LITERACY.RST.11-12.9
  Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

National Geography Standard 1: The World in Spatial Terms

1. The advantages of coordinating multiple geographic representations—such as maps, globes, graphs, diagrams, aerial and other photographs, remotely sensed images, and geographic visualizations to answer geographic questions

   A. Explain the advantages of using multiple geographic representations to answer geographic questions, as exemplified by being able to:

   - Explain how multiple geographic representations and geospatial technologies (e.g., GIS, GPS, RS, and geographic visualization) could be used to solve geographic problems (e.g., help determine where to locate a new playground, or identify dangerous street intersections within a community).
   - Describe how an analysis of urbanization can be done using different geospatial technologies (e.g., RS for land use, GIS data layers to predict areas of high/low growth, GPS and GIS for identifying transportation issues regarding growth).
   - Explain how multiple geospatial technologies can be used to solve land-use problems (e.g., effects of new farming technologies on the sustainable production of food, preservation of wetlands in bird migration flyways).

National Geography Standard 1: The World in Spatial Terms

2. The technical properties and quality of geospatial data

A. Identify and explain the metadata properties (e.g., resolution, date of creation, and method of collection) of geospatial data, as exemplified by being able to

- Explain how the metadata information is used to understand differences in the creation and design of datasets (e.g., land use/land cover, street/storefront property uses, terrain features, scale) and to determine the usefulness of the data for mapping.
- Analyze the relationship between the quality of data and the source of the data (e.g., differences in reported population data by countries, boundaries as reported by different adjacent countries).
- Describe how metadata assist in determining appropriateness of the data set in relation to use or layering with other data sets.

National Geography Standard 1: The World in Spatial Terms

2. The technical properties and quality of geospatial data

B. Evaluate the quality and quantity of geospatial data appropriate for a given purpose, as exemplified by being able to

- Describe the many purposes for which a data set would be appropriate (e.g., 1:1,000,000 scale maps, 30-meter pixel satellite images, tables of state health data).
- Explain how data that are appropriate for a task at one scale may be inappropriate for a similar task at a different scale (e.g., census blocks and tracks for local data, county/parish for state or national data).
- Analyze a variety of data sets that present variations in space and time (e.g., Arctic ice in January and July, population counts for metro areas at different time periods, location and number of influenza infections by month).

National Geography Standard 1: The World in Spatial Terms

3. The appropriate and ethical uses of geospatial data and geospatial technologies in constructing geographic representations

A. Evaluate the appropriate and ethical uses of different geospatial technologies and methods for acquiring, producing, and displaying geospatial data, as exemplified by being able to

- Evaluate the appropriateness of using geospatial data that may identify particular individuals (e.g., use of cellular phone geolocation data, license plates and faces in street-view data).
- Describe and evaluate the conditions under which geospatial data should be restricted (e.g., availability of infrastructure data on web-sites, sensitive areas not displayed on satellite imagery, confidentiality of individuals when displaying health data).
- Describe and explain the appropriate documentation needed to assess the credibility of a GIS-based project (e.g., quality of data files used, processes used, steps to duplicate the project).

National Geography Standard 1: The World in Spatial Terms

4. The uses of geographic representations and geospatial technologies to investigate and analyze geographic questions and to communicate geographic answers

A. Analyze geographic representations and suggest solutions to geographic questions at local to global scales using geographic representations and geospatial technologies, as exemplified by being able to:

- Construct a presentation using multiple geographic representations and geospatial tools that illustrates alternative views of a current or potential local issue.
- Construct maps using Web-based mapping of national forest areas showing terrain, vegetation, roads, hiking trails, campsites, and picnic sites to identify possible new areas of public use, trails and roads, and areas to close for habitat recovery.
- Analyze the possible relationships between global human and physical changes using GIS (e.g., the relationship between global climate change, sea level rise, and population distribution).

STEM Experiences

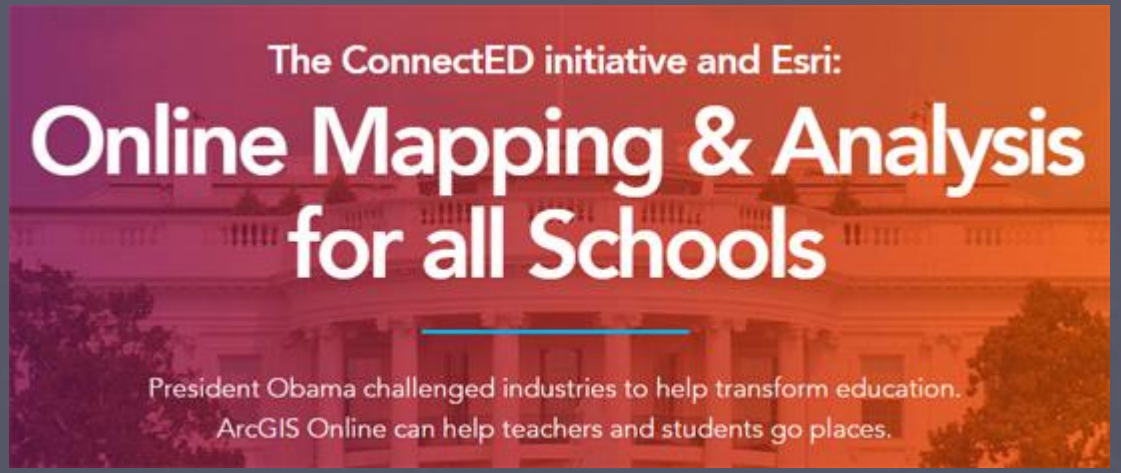
- STEM Classes offer great opportunities to partner with businesses and local government to give students real-world experience and ideas on application
  - **ST1.10** Community, post-secondary, business/industry partners and/or families actively support and are engaged with teachers and students in the STEM program.
  - **ST1.11** Students are supported in their STEM learning through adult-world connections and extended day opportunities.
  - Student Example

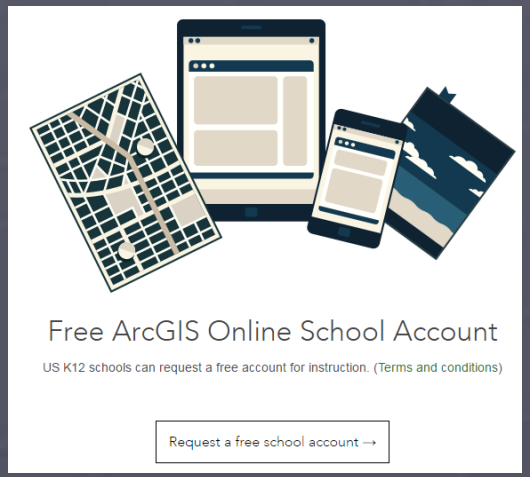
Suggested Students

- STEM and GIS can be incorporated into just about any class. It especially opens up the possibilities for cross-curricular projects.
  - **ST1.1** The STEM school/program supports non-traditional student participation through outreach to groups often underrepresented in STEM program areas.
- There is a bit of a learning curve with GIS
  - Use the ArcGIS Online Skill Builder for an idea of what type of skills are required for GIS and to decide what types of activities to incorporate in with your students

Esri's ConnectED Initiative

- Esri has provided $1 Billion worth of free access for K-12 Institutions to ArcGIS Online
- Institutions can sign up for free institutional accounts
  - Given 1,000 credits to use that can be refreshed annually
- Esri has also developed pre-made lessons for Geography, US History, Earth Science, Environmental Science, and 4th Grade Interdisciplinary classes
- www.esri.com/connected





Getting Started

Get Training

- Biggest challenge to beginning a course is getting teachers with appropriate training
  - Esri Mooc Lessons
  - Esri Training

Connect with a GeoMentor

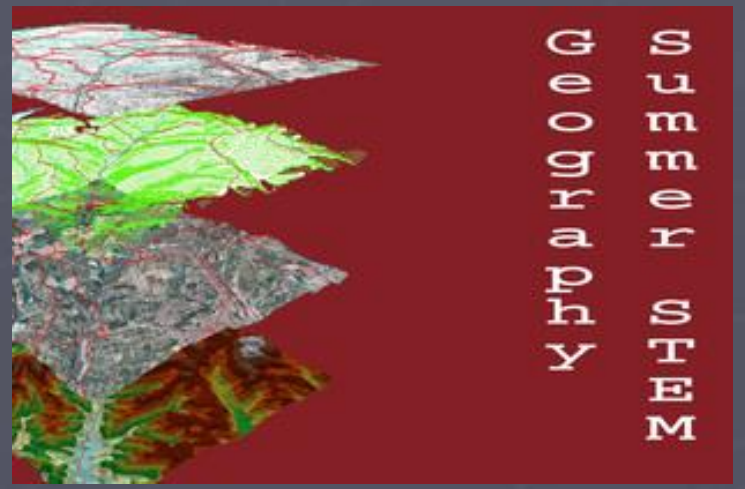
- GeoMentor program allows teachers to connect with local GIS experts
  - Technical help
  - Ideas for projects and community integration

Suggested Setup

- Computer Lab or Bring Your Own Device
  - ArcGIS is Cloud Based
  - A computer with a mouse is recommended

Example Course Outline – Semester

- Unit I – Basics of Cartography (3 Weeks)
  - Basics of Geographic Study, Cartography
    - Developments of Geography/Cartography, Map Projections, and elements of a map
- Unit II – Principles of GIS (2 Weeks)
  - Course specific vocabulary and concepts
    - Data, Layers, GIS mapping terms, Scale
- Unit III – Making Maps (5 Weeks)
  - Making and Stylizing Maps
    - Dot Maps, Open Source Maps, Heat Maps, Swipe Maps, Story Maps, GeoForms
- Unit IV – Analysis (3 Weeks)
  - Performing Analysis using ArcGIS
    - Downstream, Drive-Time, Find Nearest, Service Areas, Data Enrichment
- Unit V – Projects (6 Weeks)
  - Applications of Course Concepts
    - Map Contest, Propose a World Cup site



Integrative Learning:

- GIS can be used in any subject area
- In STEM the idea of project based real-world learning matches with the capabilities of GIS
  - Below are two examples of GIS Learning Environments that focus on an integrative project based real-world learning experience

AP GIS&T Course

- In the Summer of 2016 the American Association of Geographers submitted a course proposal for an AP Geographic Information Systems and Technology course to the College Board
  - In Development
  - Need High Schools and Universities to sign Attestation Forms to offer it
  - Apgist.org