Power of Data Teacher Guide

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INTRODUCTION TO POWER OF DATA

Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

The Power of Data or POD Project, which focuses on Geospatial Inquiry, has been providing professional development to diverse groups of secondary teachers since 2009. POD professional learning programs enable secondary teachers to use Geospatial Inquiry to increase 6-12 grade students' geospatial analysis skills, 21st century workforce skills, geospatial technology (GST) capabilities, and science, technology, engineering and mathematics (STEM) career awareness.

POD project evaluators have found that teachers who participated in past POD professional development increased their technological and pedagogical skills and confidence teaching with Geospatial Inquiry. Participating teachers implemented lessons which provided more opportunities for students to analyze data and make claims based on spatial evidence. POD programs have impacted learning for approximately 1,600 secondary and post-secondary students.

WHAT YOU WILL EXPERIENCE IN THE POD TEACHER WORKSHOP

You will **engage in adult-level, Geospatial Inquiry with a focus on science.** This will serve as an example for you to create a similar Geospatial Inquiry for students in your specific content area. The lessons you will experience are not intended for use in K-12 classrooms.

You will engage in a common **Geospatial Inquiry experience** as a learner**:**

- **EXAMINE** geospatial data
- **ASK QUESTIONS** about geospatial data
- **ANALYZE AND INTERPRET** geospatial **data** with the help of geospatial technologies
- **ENGAGE IN ARGUMENT** using geospatial data as **EVIDENCE** to support written arguments
- Present and receive feedback on your argument to peers
- **REVISE** your argument based on peer feedback.

You will practice **21st century skills**:

- **Think critically** about geospatial data
- Use **creativity** to display patterns of geospatial data
- **Communicate** claims using geospatial data as evidence
- **Collaborate** with peers throughout the process

You will **reflect** on your experiences:

- **Consider** to what extent these experiences affected your conceptual understanding
- **Plan** how you might provide a similar learning experience for your students

You will **consider** how **Geospatial Inquiry** can enhance student **learning:**

- Know how technology tools and resources can be used to support Geospatial Inquiry
- Become familiar with technology tools and resources that support Geospatial Inquiry

By the end of this workshop you will be prepared to (and feel confident in) implementing Geospatial Inquiry in your classroom.

WHAT SHOULD YOU EXPECT?

The focus of this workshop is for you to consider how Geospatial Inquiry with the aid of geospatial technology, specifically, ArcGIS Online, can help learners increase their understanding of important concepts and communicate their understanding to others. You might increase your knowledge of Earth Science concepts, and you might learn some geospatial technology skills, but these are not the main goals of this workshop.

Structure for each session

- Geospatial Inquiry
- Implications for Teaching with Geospatial Inquiry
- Pedagogical Moves to Support Geospatial Inquiry
- Career Spotlight
- Designing a Geospatial Inquiry
- Metacognition
- Homework

Why the POD Teacher Workshop is Structured this Way

The POD approach is simple. Teachers must build their knowledge and skills in order to effectively ***teach with*** geospatial technologies. One way to do this is to experience ***learning with*** geospatial technologies. When we engage in a Geospatial Inquiry, we are not learning the technology for the sake of learning the technology, but rather using the technology to enhance our abilities to find patterns and relationships in geospatial data for a **purpose**. We use the technology to better understand important concepts and to communicate our ideas to others.

You are all professionals. Everyone comes to the POD Teacher Workshop with different knowledge, skills, and experiences to draw from. The collaborative *Geospatial Inquiry* provides a common ground from which we can collectively contemplate the elements of the experience. We can more easily discuss the concepts, practices, strategies and skills explicitly afterwards if we actively experience the same Geospatial Inquiry.

Geospatial Inquiry involves geospatial thinking, which involves the analysis of data tied to a location on the Earth's surface. We employ a geospatial analysis framework to guide our interpretation of geospatial data.

This framework helps us find relationships and patterns in geospatial data that help us answer questions and explain phenomena:

- Examining where things are
- Finding areas of concentration
- Examining most and least
- Finding what's inside
- Finding what's nearby
- Examining change over time

We have learned a great deal from teachers who have implemented Geospatial Inquiry in their classrooms. In *Implications for Teaching with Geospatial Inquiry*, you will hear their stories so you can consider how their experiences compare to your own classroom. In the same vein, during *Pedagogical Moves to Support Geospatial Inquiry* strand, academically productive talk is highlighted as a strategy to support implementation of Geospatial Inquiry.

One of the goals of the POD project is to increase opportunities for students to engage in Geospatial Inquiry so they might be inspired to enter exciting geospatial careers. Thus, in the *Career Spotlight* strand, a few interesting cases are highlighted so you can consider how you might use these to inspire your students.

A structure is provided to help you *Design a Geospatial Inquiry* lesson to enhance an existing unit. You will be guided through the process so you will be prepared to implement the Geospatial Inquiry when you return to your classroom.

Finally, at the end of each session you will have time to reflect as both a learner and as a teacher and to prepare for the next session's learning.

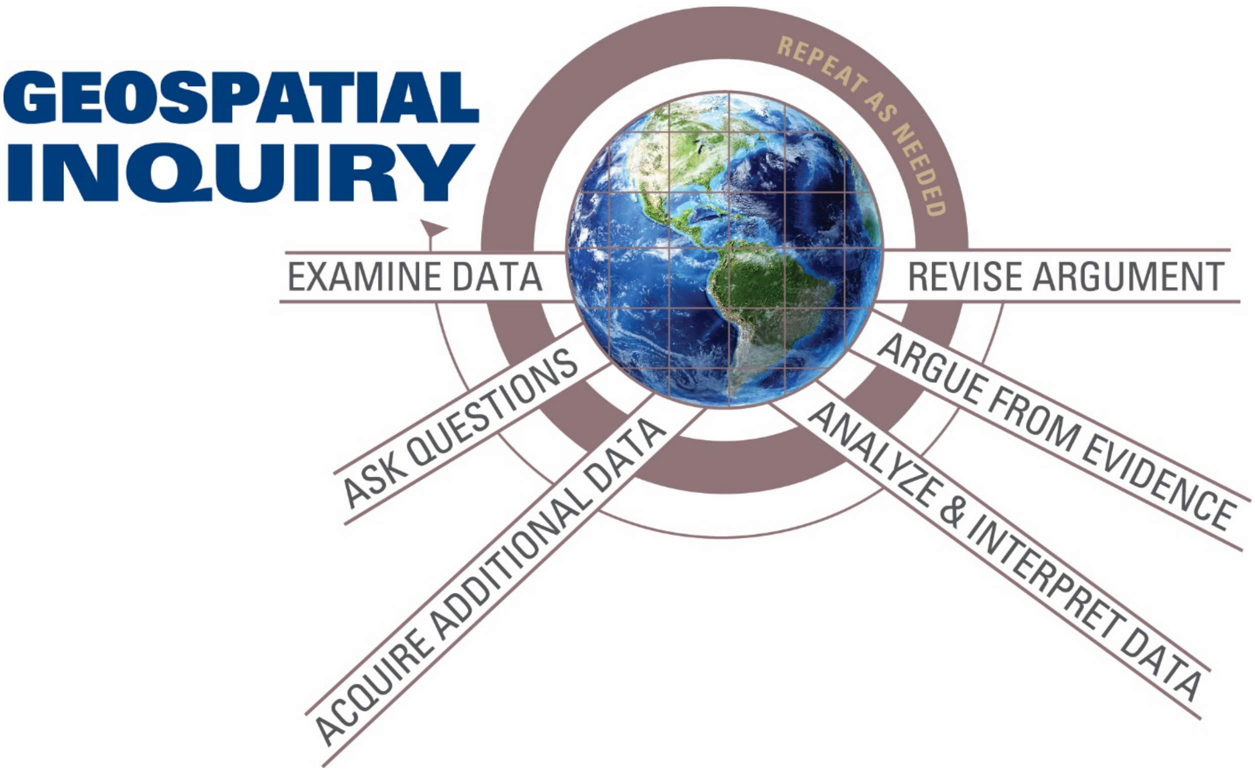
GOALS FOR TEACHERS IN POD TEACHER WORKSHOPS

- Increase understanding of Geospatial Inquiry
- Increase confidence and skills for facilitating Geospatial Inquiry with students
- Identify opportunities to implement Geospatial Inquiry to enhance student learning of key disciplinary concepts
- Increase awareness of careers that could inspire students to enter STEM fields

WHAT IS GEOSPATIAL INQUIRY?

POD defines Geospatial Inquiry as:

> Asking and answering a question through the analysis and communication of data that is linked to a geographic location on, above, or near Earth. These data are often represented visually via maps.



Geospatial Data:

Geo: of or pertaining to Earth

Spatial: of or pertaining to space

Data: facts and statistics collected together for reference or analysis

Geospatial Inquiry is a continual process which includes multiple phases and no beginning or end. Sometimes, a Geospatial Inquiry starts with a digital map that includes some points, lines and polygons, or layers. These layers correspond to locational information, data, facts and statistics that can be displayed in a geographic information system (GIS), like ArcGIS online.

For example, consider an online map that displays data from the Center for Disease Control. Each layer on the map is represented by points, lines, polygons, and/or images which represent features such as individuals who display symptoms of a disease, healthcare facilities, and roads and waterways. Because the map is displayed in an online map viewer, one can zoom, pan, and click around the map to **EXAMINE GEOSPATIAL DATA.** Questions might then arise around why the features appear where they do. Upon further exploration of individual features on the map, it becomes apparent that each feature often has a lot more information associated with it than meets the eye. Some features have several attributes, or characteristics attached to them. For example, a point could represent a health clinic, but upon closer inspection, may also include data about the total number patients treated within a certain time period, their ages, their symptoms, diagnoses, treatments and mortality rates. These data are displayed by opening the attribute table that is associated with the feature. Knowing this, one can begin to **ASK QUESTIONS** and look for patterns and relationships in the data. For example, could there be a relationship between the occurrences of malaria and proximity to standing water? With a question in mind, one can begin to **ANALYZE AND INTERPRET GEOSPATIAL DATA.** The data can be filtered to only display malaria cases. Then the program can calculate how many instances of malaria occurred within a certain distance to a body of water. Armed with this information as evidence for a claim about this relationship, the data can be displayed for any intended audience, serving as evidence for claims. Stakeholders can provide feedback and **ARGUMENTS** can be **REVISED** as new evidence becomes available. At any given point along this geospatial inquiry, more **QUESTIONS** may arise, and additional **GEOSPATIAL DATA** may need to be **ANALYZED AND INTERPRETED** in order to make an informed decision or better understand whatever the new investigation.

WHY GEOSPATIAL INQUIRY IN THE CLASSROOM?

According to some estimates, up to 80% of the world's data has a geospatial component to it. Demographics, watersheds, precipitation, temperature, real estate values, transportation routes—these are all examples of geospatial data. Critical issues facing our world, including the environment, economy and security, depend on an understanding of geospatial relationships. Therefore, it is important for students build their capacity to reason with geospatial data to make decisions and better understand their world.

Geospatial Inquiry engages students in geospatial thinking, which requires exploration of relationships between features tied to locations on Earth to better understand the world. Because Geospatial Inquiry employs powerful geospatial technology tools, students are able to critically analyze authentic datasets in ways they would not be able to otherwise. When incorporated to support existing learning activities like research, field work, and laboratory investigations within the context of a discipline, Geospatial Inquiry can enhance student learning. The geospatial perspective can contextualize core ideas in many subject areas to make them more relevant for students.

HOW DOES GEOSPATIAL INQUIRY ALIGN WITH PRACTICES ACROSS DISCIPLINES?

Geospatial Inquiry enables students to engage in core practices in many disciplines including science, history, and geography. Geospatially-literate students are critical thinkers. If students are equipped to take advantage of technologies that enhance their human capacities for spatial reasoning, like ArcGIS Online, they are better critical thinkers. They evaluate the quality of geospatial data. They uncover patterns and relationships. They can act upon and can make decisions based on these relationships. They use geospatial data as evidence to support written arguments, and they can consider the validity of arguments based on geospatial data.

Geospatial Inquiry Phases Aligned with Core Practices in Multiple Disciplines

Science	ELA/Literacy	History	Geography	Geospatial Inquiry Phase
Ask questions about natural phenomena set in context of core disciplinary ideas		Access prior knowledge about an investigation via examination of a map, narrative, or other historical source. Ask disciplinary questions which center on historical analysis and interpretation skills	Pose geographic questions	Examine Geospatial Data Ask Questions
Analyze and interpret data to find patterns	Integrate & evaluate content presented in diverse media, visually & quantitatively, as well as in words	Analyze, critique, and interpret relevant, conflicting sources which challenge ideas	Acquire, organize and analyze geographic information to identify relationships, patterns, distributions, clusters	Analyze and Interpret Geospatial Data
Construct evidence-based explanations	Write arguments to support claims in an analysis of substantive topics using valid reasoning & relevant & sufficient evidence	Engage in collaborative development of evidence-based historical argument	Reason about human systems, environmental systems, & human-environment interactions	Argue from Evidence
Engage in argument from evidence. Defend explanations Obtain, evaluate, & communicate information orally, in writing, with the use of tables, graphs, diagrams, & equations	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others Make strategic use of visual displays of data to express information and enhance understanding of presentations	Engage in collaborative defense and revision of evidence-based historical argument	Reason about geography; answer questions and systematically design solutions. Communicate geographic information	Argue from Evidence Revise Arguments

WHAT DOES GEOSPATIAL INQUIRY LOOK LIKE IN A CLASSROOM?

Science

Geospatial Inquiry could be used in an environmental science class to promote conceptual understanding of the Earth's system and how changes to one part of the system affect the rest of it. After **EXAMINING** a map which shows the source of their fresh water, students can consider **QUESTIONS** such as: Does the source and amount of water available make any difference on how we use it? When we don't see our source of water, how does this change our use of water? How does where we get our water and water our usage impact the region we live in? Students can **ANALYZE AND INTERPRET** datasets on regional watersheds, local water and land use, global precipitation data, and population data to make a claim about these relationships and create visual representations of the relationships to support their written **ARGUMENTS.**

History

After **EXAMINING** a map, letters and historical photos of the aftermath of the 1906 San Francisco earthquake, students in a history course might **ASK:** what population was most affected by the disaster? Where was the most damage incurred? How long did it take the city to recover? Were certain populations more vulnerable than others? In order to answer the questions, students can **ANALYZE AND INTERPRET** historical census data in comparison to the earthquake and infrastructure data to make a claim about these relationships and use the visual representations as **EVIDENCE** to support written **ARGUMENTS.**

Design Principles for Teaching with Geospatial Inquiry

The following Design Principles informed the Geospatial Inquiry cycle and the POD Teacher Workshop.

Geospatial Inquiry Design Principles

1. Geospatial Inquiry is used for a **purpose**: to provide relevant, engaging, authentic learning experiences through the process of answering a question, solving a problem, or explaining a phenomenon.

2. Geospatial **technologies are tools** that support Geospatial Inquiry: to make sense of **relationships and patterns** in geospatial data and to create **visual representations** which can be used as evidence to support written arguments.

3. Geospatial Inquiry promotes **cross-disciplinary practices** and **21st century skills** such as collaborating and participating in a learning community with peers to ask questions, creatively select and display appropriate geospatial data, critically analyze and interpret geospatial data, and engage in argument using geospatial data as evidence to communicate ideas to diverse audiences.

4. Geospatial Inquiry is a **reflective practice**. It starts from prior knowledge and experience and requires metacognition in order to develop conceptual understanding.

5. Geospatial Inquiry is **socially constructed**. It provides opportunities to collaborate, compare ideas with others, and receive feedback on those ideas through productive, equitable and respectful discourse. Viewing all ideas as resources can advance the knowledge of a learning community.

6. Geospatial Inquiry is **iterative and sequenced over time** to promote **conceptual understanding** of big disciplinary ideas and to scaffold technological and communication skill development.

7. Engaging in Geospatial Inquiry and seeing how Geospatial Inquiry is used by professionals provides inspiration to enter **STEM careers**.

REFERENCES

Common Core Standards Initiative (2012). *Common core state standards for English language arts & literacy in history/social studies, science, and technical subjects*. http://www.corestandards.org/read-the-standards/

Lesh, B. A. (2011). Why won't you just tell us the answer? *Teaching historical thinking in grades*, 7-12. Stenhouse Publishers.

Mitchell, A. (1999). *The Esri guide to GIS analysis. Volume 1: Geographic patterns and relationships*. Esri Press. Redlands, CA.

National Council for Geographic Education. http://www. ncge.org

National Council for the Social Studies. (2013). The college, career, and civic life (C3) framework for social studies state standards: Guidance for enhancing the rigor of K–12 civics, economics, geography, and history. http://www.socialstudies.org/system/files/c3/C3-Framework-for-Social-Studies.pdf

National Research Council. (2000). *How people learn: Brain, mind, experience, and school*. Expanded edition. Washington, DC: The National Academies Press.

National Research Council. (2006). *Learning to think spatially*. Washington, DC: The National Academies Press.

Partnership for 21st Century Learning. (2007). *Framework for 21st Century Learning*. www. p21.org

Schell, E. M., Mohan, A, & The Instructional Materials and Professional Development Committee. (2013). Road map for 21st century geographic education: Instructional materials and professional development. *The Geography Teacher*, *10*(1), 6-14.

Schweingruber, H., Keller, T., & Quinn, H. (Eds.). (2012). *A Framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.

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ARCGIS ONLINE TASK CARDS

Use these cards for easy reference to tasks completed throughout the Workshop.

Task #1: Log-in and Explore the Interface of ArcGIS online

- Go to ArcGIS.com
- Log-in to your account in the POD ORG
- Click on Map to create a new map
- Click on Basemap and click on different options (show "Imagery" and "Oceans")
- Search for location (type in your town/city in the "Find address or place" box). Bookmark this location
- Click on the Measure tool to measure a distance from or area around the location you selected
- Scroll/pan around, zoom in/out, and press "home" icon to return to original extent of map
- Use the Bookmark to return to your saved location
- Note that when you zoom in and zoom out with Basemap, scale dependent features show up and disappear depending on how much you are zoomed in or zoomed out.

Task #2: Create Map Note Layer and Save the Layer with the ORG

- Click on Add button, choose Add Map Notes
- Enter an appropriate name for the Map Note
- Choose the tool that fits your need (Points, Text, Lines, or Areas)
- Click on map to add your point, text, line, or area to the map
- Enter a title and description
- (*Optional*) Add an image link to "Image URL" (to display image in popup) and "Image Link URL" to go to a website
- Click Close
- When done – Click the Edit button
- In the Contents pane – Hover over the layer name and click on the "**...**" – choose "Save Layer" to save the layer. Save the map if you want to save this layer in your current map.
- In the Contents pane – Hover over the layer name and click on the "…" again, choose "Show Item Details". Click on the "Share" button and then click on "Power of Data"

Task #3 Add a Data Layer

- Click on Add button, choose Search for Layers
- In the *Find:* box (enter search term)
- In the *In:* box (choose ArcGIS Online) – **DO NOT SKIP THIS STEP**
- Uncheck the "Within map area" checkbox
- Examine the metadata for the layer by clicking on the layer title in the search results and then "Item Details"
    - Read the summary and about the source
        - Does this data layer help us answer our guiding question?
        - Is the data layer from a credible source?
    - If so, click Add to add it to your map
- Click Done Adding Layers
- If necessary, expand the layer by clicking the arrow next to the layer name and to display the layer, click in the box next to the layer (there will be a checkmark in the box when the layer is "on" and visible)
- Examine the Content & Legend icons above the word Contents

Task #4: Analyze Areas of Concentration (Density)

- Click on the Analysis button (next to Basemap)
- Select an appropriate point or line layer for concentration analysis (e.g. earthquakes, tornados)
- Select Analyze Patterns
- Select Calculate Density
- Be sure that the layer you are analyzing is selected in Box 1
- The count field should be left as "No count field"
- Enter a new name for the result layer you are creating
- Be sure that the Use Current Map Extent button is unchecked
- Save result in box to a folder in your Org account
- Click on Show credits to review consumption (is this a reasonable number of credits? If very high, perhaps reduce the zoom area on the map)
- Click the RUN ANALYSIS button

Task #5: Table Functions, Symbolizing Data and Thematic Mapping

Display an item's data table:

- Hover over a layer in the Content pane to display the icons below it
- Click on the Table icon to "Show Table"

In the table:

1. Click on the column header
2. Sort by column – ascending or descending

Other table options:

Select features from a table:

1. Click on a row to select a feature
2. Select multiple rows in table by depressing shift key and clicking on first and last rows to display on the map (to select noncontiguous rows, click on control key (PC) or command key (Mac) and click on desired rows) - Note highlighted points on the map
3. Click on Options to Show Selected Records, Center on Selection, or Clear Selected Features

Filter by One Variable (e.g. Earthquake Magnitude)

1. In the table, click on Options - Filter
2. Set Filter Criteria (e.g. Magnitude is greater than 7.9)
3. Apply Filter

Change Styles (Symbology):

- To display the same layer in different ways, be sure you are in the Content pane
- Click on "…" next to the layer and select "Copy" (NOTE: this option is not always available on content added from ArcGIS Online)
- Click on "…" next to the layer and select "Rename" to change the new layer name

In the Content pane:

1. Thematic mapping by depth (color)
    a. Hover over the layer
    b. Click on Change Style icon
    c. Choose an attribute to show – (e.g. Depth_km)
    d. Click on Counts and Amounts (**Color**) Options button
    e. Choose Classify Data
    f. Change classes to 5
    g. Click OK and Done

2. Thematic mapping by magnitude (size)
    a. Hover over Data layer
    b. Click on Change Style icon
    c. Choose an attribute to show – (e.g. Magnitude)
    d. Click on Counts and Amounts (**Size**) Options button
    e. Under "Classify Data" choose Natural Breaks
    f. Change classes to 5
    g. Change Size – Max from 50 to 25
    h. Click OK and Done

3. Filter
    a. Hover over Data layer
    b. Click on Filter icon
    c. Create expression using attribute, greater than, less than, is, etc.
    d. Choose value, field or unique numbers
    e. Apply filter

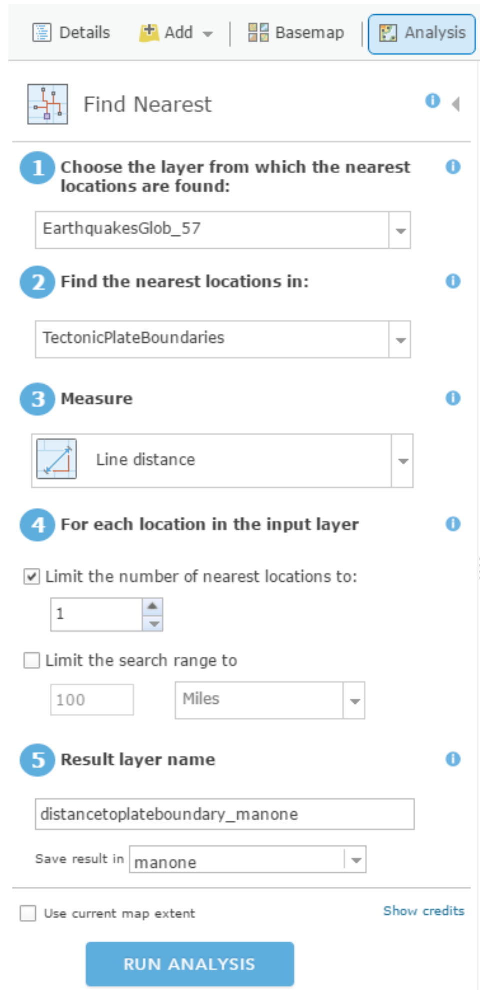
Task #6: Find Nearest and Find Average Distance

We are going to determine the average distance of earthquakes from plate boundaries for a given time period. To do this we are going to use the Find Nearest tool in the Analysis toolset. This tool can only work with up to 1000 features (points, lines, polygons) and we have over 2000 earthquakes in the EarthquakesGlob_57 layer. So we will filter the *EarthquakesGlob_57* layer to represent earthquakes only from 2005-2007 which will provide a subset of 846 features for our analysis. Once we find the nearest distance, we will summarize the field statistics to find the average distance.

1. In the Contents pane hover over the data layer and select the filter icon
2. In the first box select YEAR_
3. In the second box select IS BETWEEN
4. In the third box enter 2005, and fourth box enter 2007
5. Press APPLY FILTER
6. Select the ANALYSIS button on the top bar next to BASEMAP
7. Select Use Proximity
8. Select Find Nearest
9. In box 1 (the layer from which the nearest locations are found) select EarthquakesGlob_57
10. In box 2 (find nearest locations in) select TectonicPlateBoundaries
11. In box 3 (measure) be sure that it is set to Line Distance
12. In box 4, limit the number of nearest locations to 1 and uncheck the "Limit search range" box

Task #6: Find Nearest and Find Average Distance (continued)

13. In box 5 name your resultant layer



DISTANCETOPLATEBOUNDARY_*YOURNAME*

14. Be sure the Save result in box is your folder in the ORG
15. Be sure that the "Use current map extent" box is unchecked
16. Click on Show credits to review consumption (is this a reasonable number of credits?)
17. Press RUN ANALYSIS
18. There will be two layers generated, we are interested in the layer that contains the file name followed by "-Connecting Lines"
19. Hover over the "-Connecting Lines" layer and choose SHOW TABLE
20. The second field (column) should be named Straight Line Distance. This is the distance from this earthquake to a plate boundary
21. Click on the field name and Select Statistics

Task #6: Find Nearest and Find Average Distance (continued)

22. View the Average to see the average distance of these earthquakes to plate boundaries
23. Close table

Task #7 Create a Presentation

1. Save map
2. Click on Create Presentation
3. Click **+** button in Slide Properties pane
4. Type in a title for your first slide
5. Choose layers you wish to show on this slide from the list below
6. Change Basemap if you would like
7. Click on any feature on your map to open a data pop-up
8. Click the checkbox to "Include open pop-up in presentation"
9. Click on Slide List to see a list of your slides
10. Click on the Add button to add a new slide
11. Click on Duplicate to duplicate an existing slide
12. Save map after you have finished adding and editing slides
13. Click Play to view your Presentation

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GEOSPATIAL INQUIRY

POD defines Geospatial Inquiry as:

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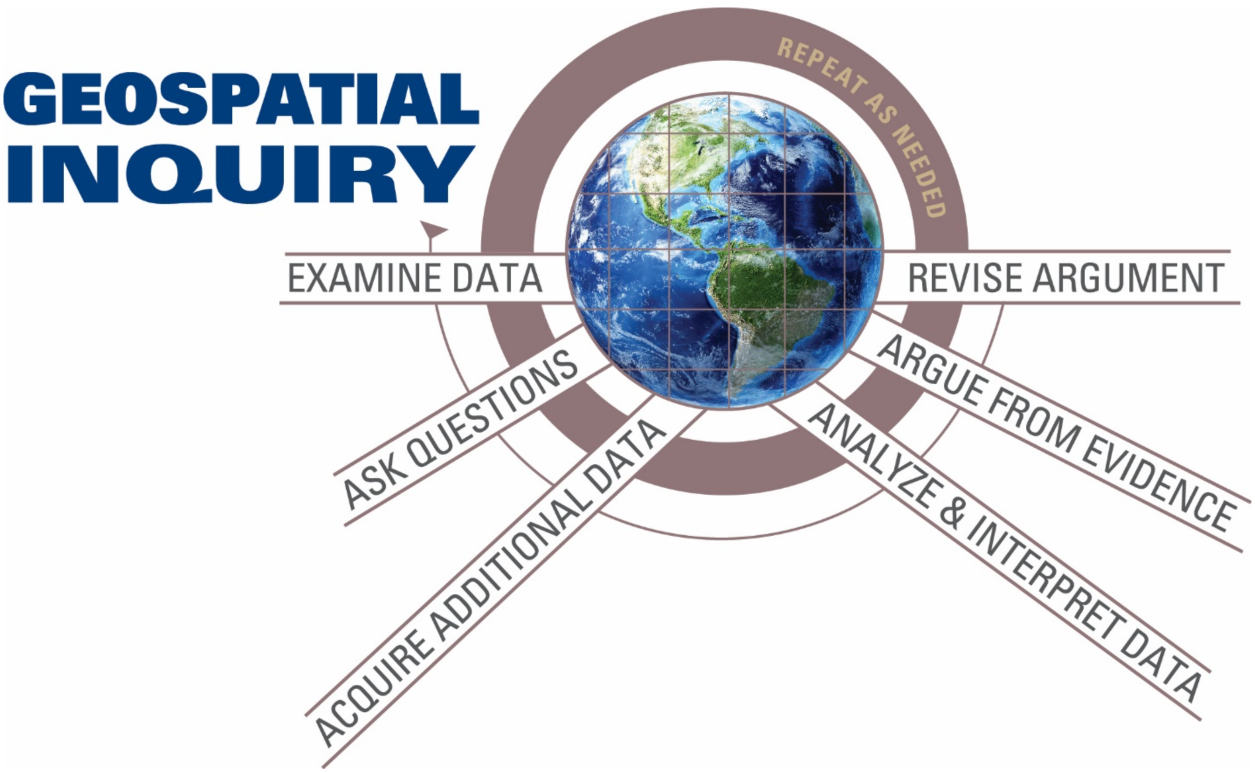

Geospatial Inquiry involves analysis of geospatial data:

Geo: of or pertaining to Earth

Spatial: of or pertaining to space

Data: facts and statistics collected together for reference or analysis

Goals for Teachers in POD Teacher Workshops

- Increase understanding of Geospatial Inquiry
- Increase confidence and skills for facilitating Geospatial Inquiry with students
- Identify opportunities to implement Geospatial Inquiry to enhance student learning of key disciplinary concepts
- Increase awareness of careers that could inspire students to enter STEM fields

GRAPHIC AGENDA

Session 1	Intro to POD	GST Pre Assessment	Geospatial Inquiry	Pedagogical Moves	Geospatial Inquiry	Metacognition, Evaluation, & Homework
Session 2	Designing a Geospatial Inquiry	Geospatial Inquiry	Career Spotlight	Metacognition, Evaluation, & Homework		
Session 3	Geospatial Inquiry	Implications for Teaching with Geospatial Inquiry	Career Spotlight	Designing a Geospatial Inquiry	Pedagogical Moves	Metacognition, Evaluation, & Homework
Session 4	Geospatial Inquiry	Implications for Teaching with Geospatial Inquiry	Career Spotlight	Pedagogical Moves	Designing a Geospatial Inquiry	Metacognition & Evaluation
Session 5	Implications for Teaching with Geospatial Inquiry	POD Research Overview	Designing a Geospatial Inquiry	Celebration	GST Post Assessment	Workshop Evaluation

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SESSION 1 POD TEACHER GUIDE

Session 1 at a Glance

Intro to POD	Geospatial Inquiry (Part A)	Pedagogical Moves	Geospatial Inquiry (Part B)	Metacognition, Evaluation, & Homework

Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

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1 GEOSPATIAL INQUIRY PART A & B

Overview of the Example Geospatial Inquiry

The example Geospatial Inquiry you will experience in the POD Teacher Workshop focuses on Hazards and Risk. It occurs over 4 sessions. It is intended to provide everyone with a common introduction to Geospatial Inquiry.

The following is an example of how Geospatial Inquiry might be added to an existing unit of study to support deeper conceptual understanding of an Earth Science concept.

We will begin by assessing the relative risk of one type of natural hazard, earthquakes, for different areas of the world. We will experience several iterations of Geospatial Inquiry, which will require us to use geospatial technologies to EXAMINE GEOSPATIAL DATA, ASK AND ANSWER QUESTIONS about geospatial data, ANALYZE the geospatial data, and develop ARGUMENTS using geospatial data AS EVIDENCE. This collaborative exploration of earthquakes will serve as an example for the assessment of risk of other natural hazards.

Note the progression of this Geospatial Inquiry – it begins with a lot of structure and guidance, but slowly progresses to allow more student choice by the end. This type of progression exemplifies how Geospatial Inquiry lessons are designed.

DISCLAIMER: The activities in this example Geospatial Inquiry are not intended for a K-12 audience. They are designed for an adult audience to demonstrate how Geospatial Inquiry works. They do not provide an exhaustive exploration of this scientific content. Our approach assumes some prior Earth Science content knowledge and stops short of teaching these concepts in depth.

GUIDING QUESTIONS

Which regions of the world are most at risk of experiencing natural disaster?

i. How can geospatial data be used to help explain where and why natural hazards occur?
ii. What patterns and relationships in geospatial data indicate high risk of disaster?
iii. How can geospatial data and tools be used as evidence to communicate risk?

Summary

The guiding questions provide a **purpose** for engaging in Geospatial Inquiry.

First, we will consider the meaning of the terms in the questions; **hazard, disaster,** and **risk.** Then we will acquire and analyze data about where earthquakes occur most frequently and consider factors that may be related to frequent and damaging earthquake events. Through the process of the inquiry, we will get to know some basic features of ArcGIS Online and use this tool to EXAMINE DATA to uncover patterns and relationships**.**

Goals

- Retrieve and examine geospatial data for a specific **purpose**
- Use ArcGIS Online as a **tool** to explore **patterns and relationships** in geospatial data
- **Critically analyze and interpret** geospatial data using Geospatial Analysis Frameworks: *Where Things Are, Areas of Concentration* and *Examining Most and Least*
- **Creatively** select and display appropriate geospatial data as evidence to support or refute a claim
- Complete one full cycle of Geospatial Inquiry as an adult learner

Quick Write

Explain what the following terms mean to you:

- Natural Hazard
- Disaster
- Risk

Terminology and representation

Compare your ideas with a partner's and also with Handout "Terminology and Representation".

What are similarities and differences in the ways these terms are represented?

Which representation/definition do you find most useful and why?

Formative Assessment

Describe the areas of the world that you think have the highest likelihood of experiencing seismic disaster.

Explore ArcGIS Online

See: Task #1 Log-in and Explore the Interface of ArcGIS online for guidance

Add a Map Notes Layer

Using the Map Notes tool, make notations on the map to indicate areas where you think major earthquakes occur most frequently. You can also use the tool to make notations about why you think earthquakes occur in these places.

See: Task #2 Add a Map Notes Layer for guidance.

If you were asked to evaluate the ideas in your map notes, what information would you want to know and what data would you want to acquire?

What we need to know	*Data we want to acquire and explore*

Be sure to save this table. You will refer to it in Session 3.

Search for and explore data related to earthquakes

See Task #3: Add a Data Layer for guidance. Note patterns here.

Examine the Earthquakes Data Layer

Search for “Global earthquakes above 5.7” and select the layer: “EarthquakesGlob_57” by Esri_TESS. Examine the data layer. What patterns do you notice?

Geospatial Analysis Framework

Analysis	How did we use it?
Examining where things are	
Examining most and least	
Finding areas of concentration	
Finding what's inside	
Finding what's nearby	
Examining change over time	

Analyze Areas of Concentration (Density)

Analyze the assigned data layer for areas of concentration. See Task #4 Analyze Areas of Concentration for guidance.

Compare your map notes prediction with this density analysis. See Task #3, Add a Data Layer for guidance. *Note: you will be searching in My Content for the Map Note layer you saved.*

Ask Questions

What additional questions did your exploration raise? Turn your statements into questions.

For example: *"I think earthquakes are concentrated near coastlines" (STATEMENT)*

"Is there a relationship between proximity to water and concentration of earthquake events?" (QUESTION)

Acquire & Analyze Additional Data (part 1)

Examine Relative Motion of Plate Boundaries (with a partner)

Open map with the following layers turned on:

- EarthquakesGlob_57
- TectonicPlateBoundaries
  - Add "Ocean Floor Age and Plate Motion" by "zwartl"
- Turn off the ocean floor age layer (You may need to click on the layer name to see which layer is ocean floor age and which is plate motion)
  - Zoom out to see global view

DISCUSS the way the data is represented/symbolized with a partner.

- What do the arrows mean?
- What does the size of the arrows mean?

DISCUSS patterns in the data with a partner. Record thoughts below.

- **Is there a relationship** between the type of plate material at the boundary (oceanic crust, continental, or both) and the concentration of high-magnitude earthquake events? If so, why?
- Is the relative motion **more** or **less** in certain areas and/or at the margin of particular plates?

Argue from Evidence

We have examined and discussed several characteristics of earthquakes and factors related to earthquake events.

Work with a partner to make a claim about the relationship between these factors/characteristics of earthquakes. Gather and analyze data to support your claim.

Possible Factors/Characteristics to Examine

- Earthquake Magnitude
- Earthquake Depth
- Type of Plate Materials (oceanic crust, continental, or both)
- Type of Plate Interaction (Convergent, Divergent or Transform)
- Velocity of Plate Motion
- You may also choose to examine other factors tied to common misconceptions about earthquakes. For example, do earthquakes occur more often in particular kinds of weather, certain times of year, during particular astronomical events?

Possible Relationships between Earthquake Factors

There is no relationship between these factors

There is a direct relationship between these factors

There is an inverse relationship between these factors

The relationship of _________________and ________________is____________

My claim is:

Can you acquire and analyze other representations of data (e.g. bar graphs, scatterplots, etc.) to examine the relationship of different factors?

Summary Table

Activity	What did we learn?	How did we learn?	How does this help us answer the guiding questions?

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1 PEDAGOGICAL MOVES THAT SUPPORT GEOSPATIAL INQUIRY

Summary

Academically productive talk (discourse), the importance of talk to support Geospatial Inquiry, and four types of discussions as they are related to the steps of Geospatial Inquiry are introduced. We utilize videos and readings from Talk Science, an NSF-funded program by TERC.

Goals

- Consider why academically productive **talk between learners** is critical for supporting Geospatial Inquiry
- Consider the relationship between the **four types of discussions** and the steps of **Geospatial Inquiry**
- Discuss how **structures** for academically productive talk can **support Geospatial Inquiry**

Excerpt from: High School Students Say Student Led Discussions and Group Work Often Go Awry

By Madeline Will on June 3, 2016 12:50 PM

Veteran education columnist Maureen Downey wrote a column for the *Atlanta Journal-Constitution* this week about "what teens resent" in school. The answer might surprise you: disrupted learning and wasted time in classes and group projects.

Downey interviewed several groups of Georgia high schoolers and repeatedly heard that students don't like it when "teachers don't intervene when students commandeer classroom discussions or divert them." She wrote:

"Repeatedly, students told me they could learn twice as much in half the time if teachers rein in their rambling peers.

The kids described unproductive classrooms where too much time is sacrificed to irrelevant chatter or tangents. A boy sheepishly said he would deliberately derail his Spanish teacher, a recent college grad struggling with classroom management, with meandering comments and 'sort of became famous for it.'"

Student-led learning has been a popular instructional strategy as teachers move away from lectures to student-directed discussions in order to let students take more control of their own learning. But clearly it can be a problem if not managed effectively: The students told Downey that when "kids decide how much and when to talk—the students end up being in charge, not the teachers ... lead[ing] to diminished learning."

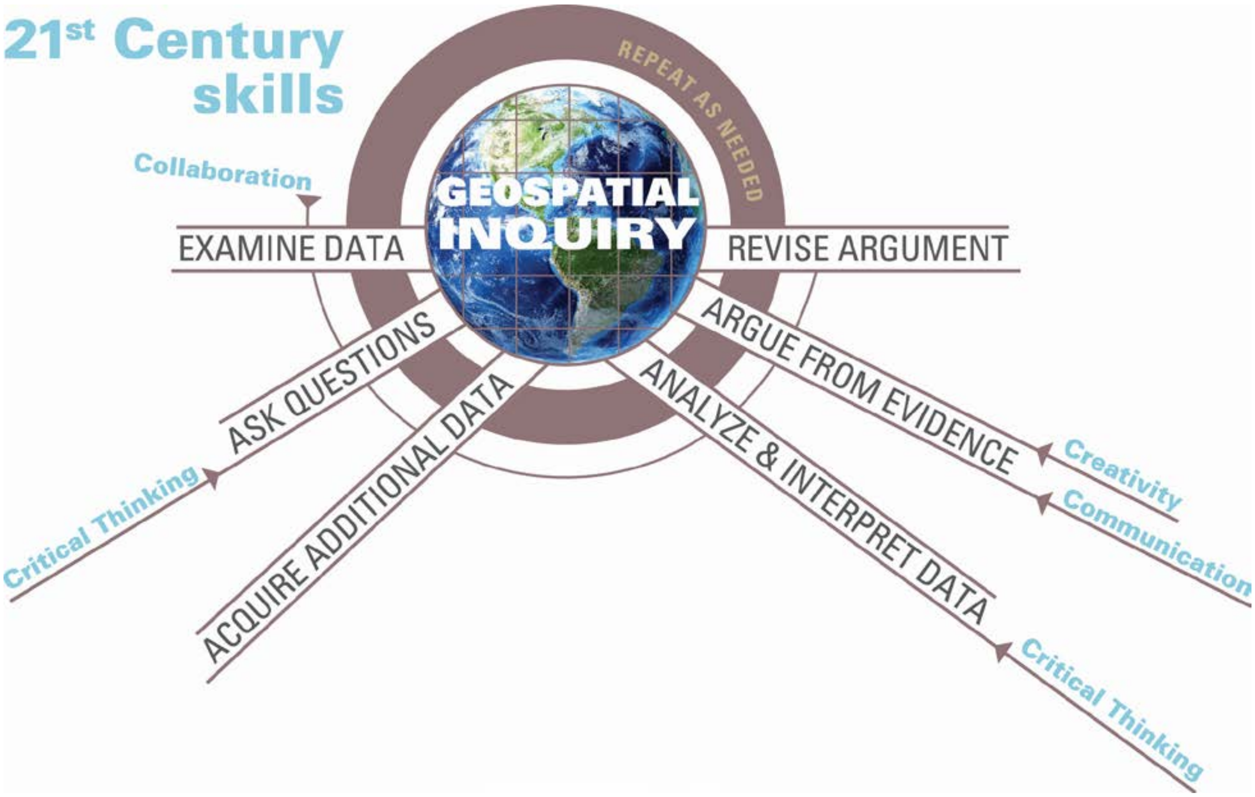
. . . Like with most things, both student-led learning and group projects have benefits despite the negative opinions.

Group work is meant to teach students collaboration, and when teachers take a step back to let students initiate the class discussions, it can empower students. In her column, Downey questions the effectiveness of student-led learning when "a few extroverts reduce discussion to recitation," but when implemented correctly, there are real benefits. Students are often more engaged, which can lead to a deeper learning. But as the stories Downey heard prove, it's not as simple as letting students take over the class discussion without teachers stopping any irrelevant tangents. It's also important for teachers to make sure all students feel comfortable to participate in the discussion.

In a Teaching Channel video, a high school English Language Arts teacher shares how she gently guides a student-led discussion while letting her students take ownership of their learning. For teachers wondering how to implement student-led learning in their own classroom without getting the kind of student reaction Downey heard, it's worth a watch.

http://blogs.edweek.org/teachers/teaching_now/2016/06/high_school_group_work_student_led_discussions.html?cmp=eml-eb-popweek+06102016

Geospatial Inquiry and 21st Century Skills



Geospatial Inquiry Phases Aligned with Core Practices in Multiple Disciplines

Science	ELA/Literacy	History	Geography	Geospatial Inquiry Phase
Ask questions about natural phenomena set in context of core disciplinary ideas		Access prior knowledge about an investigation via examination of a map, narrative, or other historical source. Ask disciplinary questions which center on historical analysis and interpretation skills	Pose geographic questions	Examine Geospatial Data Ask Questions
Analyze and interpret data to find patterns	Integrate & evaluate content presented in diverse media, visually & quantitatively, as well as in words	Analyze, critique, and interpret relevant, conflicting sources which challenge ideas	Acquire, organize and analyze geographic information to identify relationships, patterns, distributions, clusters	Analyze and Interpret Geospatial Data
Construct evidence-based explanations	Write arguments to support claims in an analysis of substantive topics using valid reasoning & relevant & sufficient evidence	Engage in collaborative development of evidence-based historical argument	Reason about human systems, environmental systems, & human-environment interactions	Argue from Evidence
Engage in argument from evidence. Defend explanations Obtain, evaluate, & communicate information orally, in writing, with the use of tables, graphs, diagrams, & equations	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others Make strategic use of visual displays of data to express information and enhance understanding of presentations	Engage in collaborative defense and revision of evidence-based historical argument	Reason about geography; answer questions and systematically design solutions. Communicate geographic information	Argue from Evidence Revise Arguments

Please Access Talk Science Primer Pages 1-6

https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

As you read, use the following annotation strategy:

Annotation Mark	Meaning
!	Surprised me
?	Prompted a question for me
✓	Confirmed something I knew

1 METACOGNITION

Goals

- Engage in **reflective practice:**
  - Review Science and Geospatial Technology learning from the session
  - Contemplate how Geospatial Inquiry enhanced individual learning
  - Consider ways to use Geospatial Inquiry in a classroom to enhance student learning

Geospatial Inquiry requires **purpose**: answering a question, solving a problem, or explaining a phenomenon. What was your purpose for engaging in Geospatial Inquiry? How did having a focus influence your learning?

What are you still struggling with?

Focus on Geospatial Analysis Frameworks

In this session, you experienced Geospatial Inquiry as a learner. You conducted geospatial analyses including "*Finding where things are*", "*Finding areas of concentration*" and "*Examining most and least*". What are some concepts you currently teach that could be enhanced with geospatial analyses?

Finding where things are (in relation to what other things?):

Finding areas of concentration:

Examining most and least

Focus on Four Types of Discussions

In this session, during Pedagogical Moves to Promote Geospatial Inquiry, you were introduced to four discussion types (Talk Science Primer, page 3). In which of these types of discussions did we engage during the sample Geospatial Inquiry on Hazards and Risk? Provide specific examples.

- Elicitation Discussions
- Consolidation Discussions
- Data Discussions
- Explanation Discussions

Reflect on the steps of Geospatial Inquiry. During which step(s) of Geospatial Inquiry might each type of discussion be most relevant?

1 Science Review

1.1 Hazard, Risk, and Disaster

In Earth science the terms ***hazard***, ***disaster***, and ***risk*** have specific meanings. There are many natural processes occurring at Earth's surface that have the potential to cause damage, injury, or death to humans. Examples include earthquakes and tsunamis, landslides, floods, tornadoes, hurricanes, and heat waves. When these processes occur far from humans or have no potential to impact humans, they are just considered natural events. If the process intersects with human civilization directly or indirectly, they present a risk.

Risk is assessed based on the likelihood of the event occurring over time, and the number of people likely to be affected by an individual event.

The ***hazard*** can have different meanings depending on the process. For example, the US Geological Survey defines an ***earthquake hazard*** as "an estimate of the probability of exceeding a certain amount of ground shaking, or ground motion, in 50 years"[1].

If an event occurs and thousands to tens of thousands of people are negatively impacted, the event is considered to be a ***natural disaster***. In extreme events where hundreds of thousands to millions of people are affected the event may be referred to as a ***natural catastrophe***.

[1]http://earthquake.usgs.gov/hazards/learn/basics.php#hazard

1.2 What is an earthquake, what causes it, how do we locate it?

Earthquakes ***release stress*** that has accumulated in the lithosphere (the rigid outer part of the Earth, consisting of the crust and the upper mantle). An earthquake occurs when rocks break along a fracture, called ***faulting***. The scale of faulting can range from a few hundred meters to several hundred kilometers. The first point of rupture along the fault, where the earthquake originates, is the ***hypocenter*** (a.k.a. "focus") of the earthquake (Fig. 1). Rupture then propagates along the fault in all directions away from the hypocenter. In map view, the locations of earthquakes are represented by the ***epicenter***, the point on the Earth's surface directly above the hypocenter. Note that the epicenter typically does not map onto the fault trace at the surface.

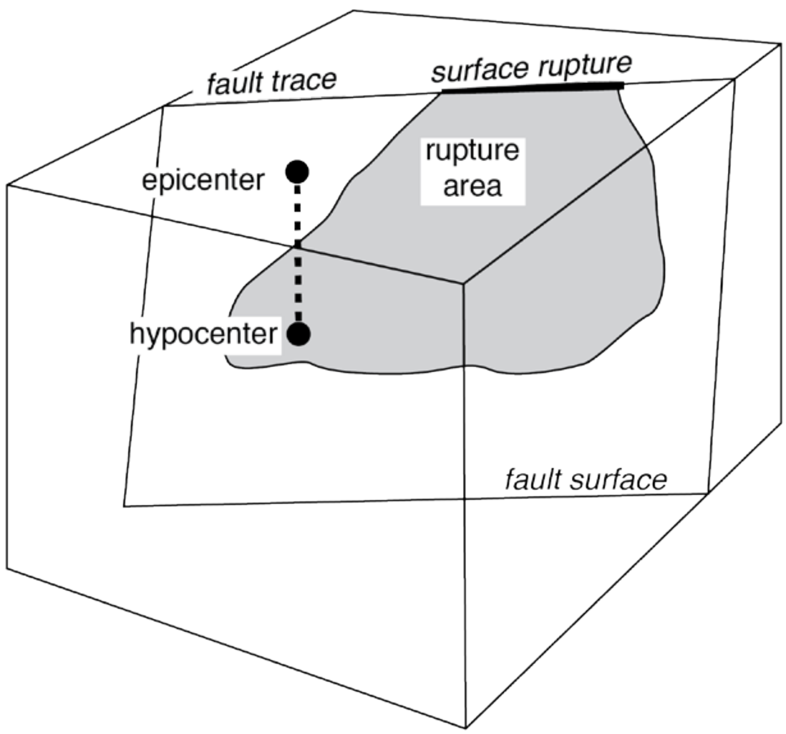


Figure 1. Relationship among fault surface, hypocenter (a.k.a focus), and epicenter. The hypocenter is on the fault surface, the epicenter is on the ground surface directly above the hypocenter. Fault rupture begins at the hypocenter and then propagates in a matter of seconds along the rupture area shown in gray. The scale is tens to hundreds of kilometers.

Earthquake rupture generates ***waves*** that radiate away from the hypocenter (Fig. 2). The first wave fronts reach the surface in the vicinity of the epicenter, but the waves also pass through the Earth and can be recorded at seismograph stations all around the globe for larger earthquakes. The main types of waves generated by the rupture are body waves, named ***P-waves*** (primary waves) and ***S-waves*** (secondary or shear waves). In addition, ***surface*** (Rayleigh) waves are generated at boundaries between layers such as the boundary between the geosphere and the atmosphere, and between the crust and mantle. Primary waves derive their name from the fact that they travel fastest through the Earth (e.g., 5000 m/s in granite) and arrive first at locations away from the hypocenter. P-waves vibrate particles back and forth in the direction the wave travels. Secondary or shear waves travel through materials more slowly, at a velocity ~60% of P-waves in the same material. S-waves do not travel through liquid or gas.

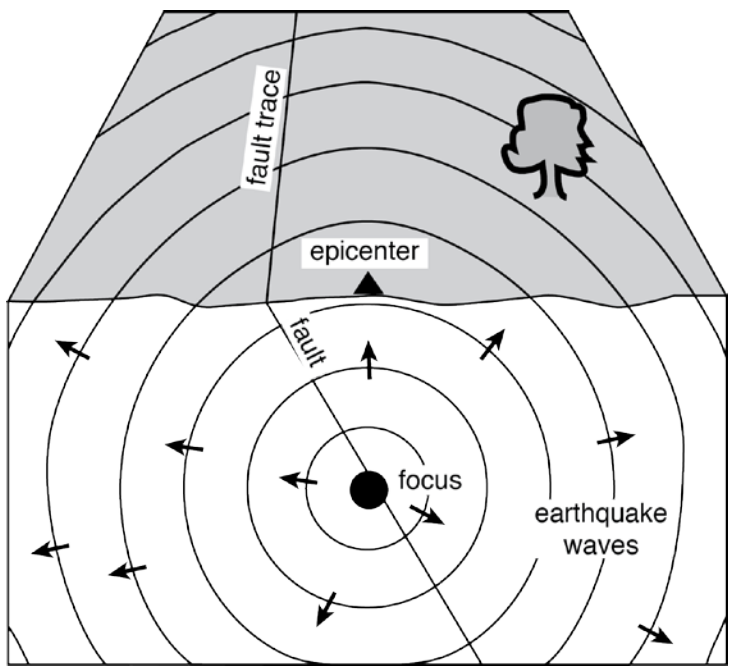


Figure 2. Earthquake waves propagate outward from the earthquake focus in three dimensions at speeds of several thousand kilometers per second. The epicenter is the first point on the ground surface that experiences shaking.

Seismologists (a type of geophysicist) measure earthquake waves using ***seismographs***; the chart of the earthquake waves is a ***seismogram***. A typical seismogram will show separate ***arrival times*** and ***waveforms*** for P-, S-, and surface waves (Fig. 3). The earthquake magnitude is determined by measuring the amplitude of one of the waves on the seismograph and has to be corrected for the type of seismograph used and the distance between the earthquake and the seismometer.

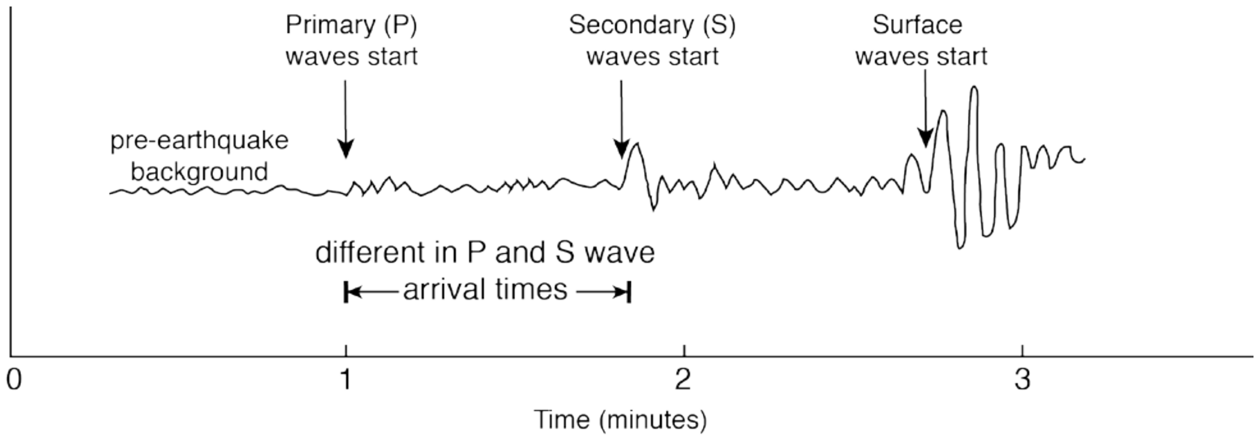


Figure 3. Schematic seismogram showing relationship among P-, S- and surface waves. S-waves travel more slowly than P-waves through Earth. Thus, the difference in arrival times of P-waves and S-waves can be used to calculate the distance from the seismograph to the earthquake epicenter. The greatest shaking at the location of the seismograph occurs when surface waves arrive.

Locating earthquakes requires seismograms from a minimum of three seismographs (in practice, hundreds of seismograms are used). The procedure works as follows. The first arrivals of P- and S-waves are noted on the seismogram. The first S-wave will always arrive after the first P-wave; this time difference is measured precisely in seconds to minutes. The time difference informs the scientist the distance from the seismograph back to the epicenter. A circle with the distance as radius is constructed around the location of the seismograph in map view. This procedure is repeated for more seismograph stations. All of the circles should have one unique point in common-this is the location of the earthquake's epicenter (Fig. 4). Earthquake depth is determined using a similar procedure for seismograph located closest to the epicenter.

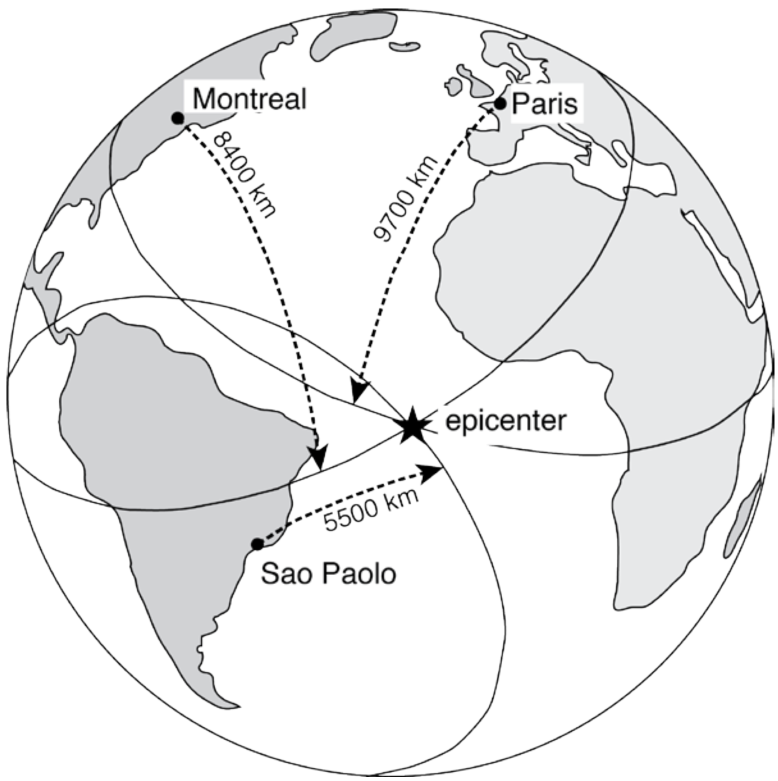


Figure 4. Method of locating an earthquake epicenter using three seismograph stations at Paris, Montreal, and Sao Paolo. The difference in arrival times of P-waves and S-waves (see Fig. 3) can be used to calculate the distance between the epicenter and each station (here 9700 km, 8400 km, and 5500 km). Circles with those distances as radii, drawn around each station, intersect at a unique point which is the epicenter. In practice many more stations are used to locate the epicenter accurately.

1.3 Information about where EQs are concentrated, including plate boundaries

A map of earthquake epicenters for moderate to large earthquakes shows that a very high percentage are located near plate boundaries. As plates slide past (***transform boundary***), under (***subduction or collision***), or away (***divergent***) from one another, stresses build and deform the lithosphere, creating ***faults***. In fact, many inactive, very old faults are in rocks that were in the past part of a plate boundary. The location of most earthquakes near plate boundaries indicates most of the deformation from plate tectonics occurs there. Plate boundaries are dynamic settings where the geosphere (the solid portion of the Earth distinguished from atmosphere, hydrosphere) is experiencing a great deal of change. They are locations of potentially the greatest hazards to human life and property.

There are systematic, but variable, earthquake locations relative to plate boundaries. At ***convergent*** (subduction, collision) boundaries, in map view earthquake epicenters are consistently to the side of the plate boundary that includes land on the overriding plate (Fig. 5).

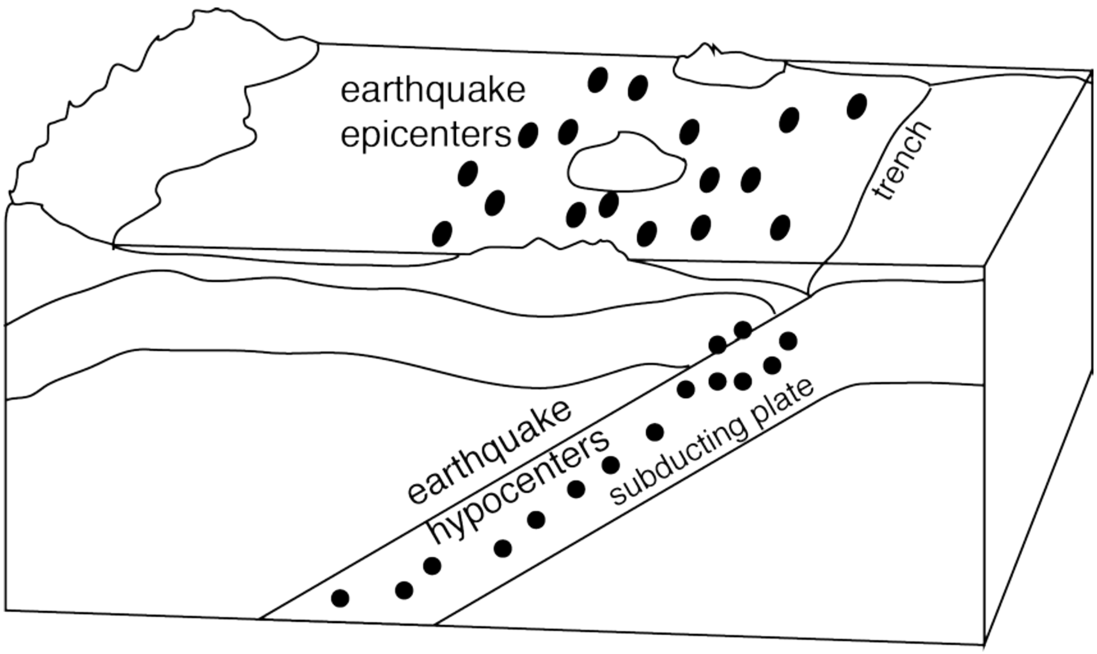


Figure 5. Earthquake hypocenters (black circles) and epicenters (black ovals) in a typical convergent plate boundary. Most earthquakes occur within the subduction oceanic plate. Depths can vary from a few kilometers to 700 km. The pattern of earthquakes at this kind of boundary is one where most epicenters are to the landward side (here shown by volcanic islands) of the trench, which is the plate boundary. The depths of earthquake increase away from the plate boundary.

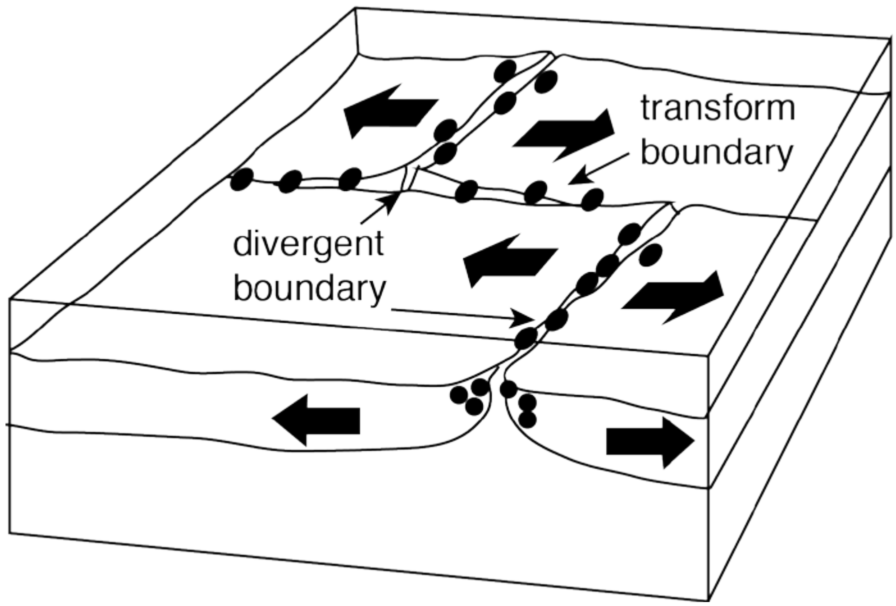


Figure 6. Earthquakes in a typical divergent and oceanic transform boundary. Hypocenters are located in the plates and are generally shallow, less than 15 km depth. In map view the epicenters occur very near the plate boundaries. These margins are most commonly deep in the ocean away from land.

The earthquakes at divergent (spreading ridges, rift zones) boundaries more typically are located along the plate boundary in map view (Fig. 6).

At transform boundaries earthquakes also tend to cluster near the plate boundary (Fig. 6). The most common earthquakes in this regime occur in oceanic lithosphere along oceanic transforms, which connect segments of spreading ridges. Continental transforms occur where transform faults cross through continental lithosphere, and these represent a greater hazard to humans. Along these boundaries there are earthquakes right along the plate boundary in map view, similar to oceanic transforms. However, there also several earthquakes located on other, parallel faults away from the plate boundary that make up a transform boundary fault zone.

1.4. Describe depth, magnitude, density, crust involved, type of margin, plate rates

At ***convergent plate boundaries*** earthquakes increase in depth away from the trench and toward the upper, overriding plate. The deepest earthquakes on Earth occur at convergent boundaries and can reach depths up to 700 km. Below this rocks are too hot and plastic to deform by fracturing along faults. Some of these earthquakes occur at the plate interface, but most are actually located on faults within the subducting lithosphere. Earthquake locations thus can be used to map out the location of the subducting slab in three dimensions (Fig. 5). In most subduction zones the downgoing slab is capped by oceanic crust, and the overriding plate is capped by either continental crust or intermediate in composition between continental and oceanic.

At both ***divergent and transform boundaries*** most earthquakes occur in the upper 10-15 km. Nearly all ***divergent*** boundaries are bordered by oceanic crust on both sides. Rare exceptions include continental rifts such as in eastern Africa. The earthquakes are generated by faults related to extension of the lithosphere (Fig. 6). The majority of ***transform boundaries*** transect oceanic lithosphere near divergent boundaries. Earthquakes are caused by plates sliding horizontally past one another (Fig. 6). Rare but prominent locations where ***transform boundaries*** transect continents include California and New Zealand.

Common Ideas

Incorrect	*Correct*
All faults are active.	(See above) Most faults are no longer active. Once a fault becomes seismically inactive, it is still a fault. Many faults were active and potentially generated earthquakes at one time, but now are relics of past deformation.
The entire fault surface ruptures during each earthquake along that fault.	Typically only a portion of the fault ruptures during one earthquake. The amount of slip along the fault may be greatest near the center of the rupture zone, and then gradually decreases to zero slip toward the edges of the slip zone.
Fault ruptures always break through to the surface.	On many faults, the amount of slip decreases to zero well below the surface. In some cases slip at depth leads to bending and folding of the Earth's surface, rather than breaking.
All earthquake waves travel the same through different materials	The type of Earth material (rocks and sediment) has a large influence on how waves travel. In some materials (e.g., granite, limestone) waves travel more quickly. In loose sediment near the surface, shaking from waves can increase dramatically.
Faults only occur near plate boundaries.	Faults occur in virtually all areas of Earth's crust. Most are geologically old, inactive structures that may be related to plate boundaries from long in the past. Some are active. Faults are evidence that the crust is brittle and can break during deformation.

Summary

- Natural disasters occur when potentially dangerous natural processes affect humans; risk is a statistical estimate of that occurring.
- Earthquakes occur when an active fault ruptures and generates P-waves, S-waves, and surface waves that radiate outward from the hypocenter.
- Earthquake waves recorded on seismograms are used to determine the magnitude and location of the event.
- Most earthquakes are concentrated near plate boundaries with different patterns of location and depth depending on the plate boundary.

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1 GEOSPATIAL TECHNOLOGY SKILLS REVIEW

In this session you explored the basics of the ArcGIS Online interface. After completing the tasks, you were able to begin the process of answering the scientific questions posed in this inquiry.

In task 1, you logged in to ArcGIS.com. By logging in to the POD Organization account, you were able to save your work. You created a new map, navigating the map using the zoom and pan tools. You then searched your hometown by typing in the location in the Find area and bookmarked that location experimenting with changing the basemap. You added a Map Note layer in task 2, and saved it in the POD Organization account as a layer that could be added to other maps.

In task 3, you added new layers by typing in specific search terms and examined the metadata and then turned data layers on and off while examining the layer details, content and legends. You analyzed areas of earthquake concentration by creating a density map using the analysis tools in task 6. Remember - without being logged into the POD organization account, you would have been unable to use the analysis tools.

There are many more analysis tools available to organization account users. For more on this, visit: http://doc.arcgis.com/en/arcgis-online/analyze/perform-analysis.htm

To review any of these skills, please reference the ArcGIS Online Task Cards in the front of your Teacher Guide. Also, see http://www.pod-stem.org/more/

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1 HOMEWORK

- Read Teacher Guide, Introduction to the Power of Data
- Explore: http://www.pod-stem.org/more/> Examples of Lessons to Modify > Instructional Materials > (direct link: http://www.esri.com/connected > Instructional Materials)
  - Advanced Environmental Science
  - Grade 4 Interdisciplinary
  - US History
  - Earth Science
  - Human Geography
  - Mapping Our World
  - Thinking Spatially Using GIS

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SESSION 2 POD TEACHER GUIDE

Session 2 at a Glance

Geospatial Inquiry	Designing a Geospatial Inquiry	Career Spotlight	Metacognition & Homework

Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

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2 GEOSPATIAL INQUIRY

Summary

We will continue to examine the relationship between earthquake characteristics and factors and refine your claim from Session 1B. Working with a partner, you will ACQUIRE ADDITIONAL DATA to determine if it supports your claim. You will learn how to ACQUIRE additional data from external sources and ANALYZING the data in ArcGIS online. Finally, you and your partner will present your ARGUMENT for peer-feedback using the ArcGIS Online presentation tool.

GOALS

- Retrieve and examine geospatial data for a specific **purpose**
- Use ArcGIS Online as a **tool** to **critically analyze and interpret patterns and relationships** in geospatial data
- **Creatively** select and display appropriate geospatial data to serve as visual **evidence for written arguments**
- **Communicate** ideas and engage in **collaborative**, academically productive talk to deepen conceptual understanding for all learners
- Complete a full cycle of Geospatial Inquiry as an adult learner

GUIDING QUESTIONS

Which regions of the world are most at risk of experiencing natural disaster?

I. How can geospatial data be used to help explain where and why natural hazards occur?
II. What patterns and relationships in geospatial data indicate high risk of disaster?
III. How can geospatial data and tools be used as evidence to communicate risk?

<u>Argument from Evidence</u>

Examine the relationship between earthquake factors and characteristics of earthquake (from Session 1b). Make a claim about the relationship of two earthquake factors/characteristics that helps answer the question: **What patterns and relationships in geospatial data indicate high risk of disaster?**

What is your <u>claim</u>?

- Does your claim answer the question or explain the problem/phenomena?

What is your <u>evidence</u>?

- Is all the data from a credible source?
- Does all the data support the claim?
- Are there other ways to interpret the data?

What is your <u>reasoning</u> that your data counts as evidence to support your claim?

- My claim is ___________________
- If this claim is true, then when I examine the data I would expect to see_____________________.
- The reason I'd expect to see this is because________________________________.
- If this claim was not true, then I'd expect to see________________________________.
- There may be other explanations for the data, such as ___________________.

MORE INFORMATION on ARGUMENT FROM EVIDENCE:

Article from Ambitious Science Teaching: Helping students talk about evidence: A guide for science teachers.
http://ambitiousscienceteaching.org/pressing-evidence-based-explanations/)

Acquire and analyze Additional data (to support or refute your claim)

NOTE: ArcGIS Online will only display up to 1000 points. Plan accordingly.

Add earthquake data from USGS as a CSV File

- Navigate to USGS Earth Hazards Program - Search Earthquake Catalog http://earthquake.usgs.gov/earthquakes/search/
- Fill in your search criteria (e.g. magnitude, date/time, geographic region, etc.)
- In the “Output Option” select “CSV” format
- Open the downloaded file and save as “*title of your choice*.csv”
- Go back to ArcGIS Online map tab
- Click on Add – Add Layer from File
- Browse and select the saved file “*title of your choice.csv*”
- Click Import Layer
- Click Done

Does this data support your claim?

Symbolize and display patterns & relationships

Consider the related factors and characteristics of earthquakes in your region. What does this indicate about the risk to the area?

SYMBOLIZE the earthquake data to illustrate relationships between earthquake characteristics. Explore the table, change the Styles, and calculate what's nearby. Use the ArcGIS Online Task Cards (Task #5 and #6) as a reference.

What is the value in symbolizing this data in this way? If/how does this help you answer your questions?

> The languages of science are composed not only of words, but of symbols, actions, and images as well. The symbols one chooses can help illuminate patterns in the data and enables communication of those patterns to others.

Return to Geospatial Analysis Framework

Which of geospatial analyses have you conducted thus far? Which might you consider using to support your claim?

Geospatial Analysis Framework

Analysis	How might you use it?
Examining where things are	
Examining most and least	
Finding areas of concentration	
Finding what's inside	
Finding what's nearby	
Examining change over time	

Prepare a Presentation

PREPARE a PRESENTATION of your CLAIM, supported by EVIDENCE and REASONING.

See ArcGIS Online Task #7 for guidance.

Peer Feedback

Take notes during the presentations on sticky notes. Categorize feedback on the following:

____ was interesting (!)	_____raised a question or was unclear (?)
_____extended findings that we discussed about ____ (+)	_____was in contrast to the findings that we discussed about___ (-)

Summary Table

Activity	What we learned	How we learned it	How does this help us answer the guiding questions?

2 DESIGNING A GEOSPATIAL INQUIRY

Summary

This component of the POD Teacher Workshops is designed to help you plan for one Geospatial Inquiry to supplement an existing lesson. First, brainstorm ideas of concepts you currently teach that could be enhanced through Geospatial inquiry. Then the Geospatial Inquiry Template is introduced. Select a big idea/concept and possible guiding questions that will guide a Geospatial Inquiry you can implement within the next 6 months.

Goals

- Brainstorm a list of concepts that might be **enhanced** through the exploration of **relationships and patterns** in geospatial data in a Geospatial Inquiry
- Identify a **purpose** to drive a Geospatial Inquiry that can be implemented with students

Brainstorm Geospatial Inquiry Lesson Concepts

Geospatial Analysis Framework

- Examining where things are
- Finding areas of concentration (density)
- Examining most and least
- Finding what's inside
- Finding what's nearby
- Examining change over time

Example:

Big idea/Concept/Standard: *Most major earthquakes occur along or near plate boundaries. The largest tend to occur where one plate subducts beneath another or where two continental pieces of plates slide past one another. These natural hazards become disastrous when they occur near densely populated areas or critical infrastructure.*

Guiding Questions or Claims Students Could Investigate: *Does San Francisco, CA have a higher risk of seismic disaster than other large international cities?*

Types of Geospatial Analyses: *Where things are (locations of major EQs), what's nearby (major cities, plate boundaries, types of crust, critical infrastructure), areas of concentration (of major EQs, of population)*

Brainstorm Geospatial Inquiry Lesson Concepts

What are some **important concepts** you currently teach that could be enhanced by Geospatial Inquiry? List them below.

Examples:

*A lesson on **Earth's limited natural resources** could be enhanced by having students **examine what's nearby** our local water supply*

*A lesson on the concept of **human migration** could be enhanced by having students **find areas of concentration** of immigrants in the US during the Gold Rush*

Types of Geospatial Analyses:

For each concept listed above, what kinds of analyses might students conduct? What kinds of data might they explore to better understand the concept? Refer to the Geospatial Analysis Framework for ideas.

Geospatial Analysis Framework

- Examining where things are
- Finding areas of concentration (density)
- Examining most and least
- Finding what's inside
- Finding what's nearby
- Examining change over time

Share your ideas with your small group and record them on chart paper. Use the color code provided to indicate the types of geospatial analysis involved.

Geospatial Inquiry Template

Teacher

Grade level(s)

Subject(s)

Existing lesson/unit to be *enhanced* by Geospatial Inquiry

Anticipated timeframe

Anticipated implementation (month, year)

Begin with the End in Mind

What essential understanding will students gain from completing this Geospatial Inquiry-enhanced lesson/unit? A concept is an idea that can be applied in multiple contexts to explain and/or predict outcomes. Conceptual understanding is ability to apply a big idea/concept in multiple contexts to explain and/or predict outcomes.

Have you written a statement that allows students to apply a broad idea in multiple contexts to explain and/or predict outcomes?

Ask Questions

Craft a guiding question which provides a purpose for engaging in the Geospatial Inquiry-enhanced lesson/unit. The statement should encompass all content and outcomes and should require to answer a question, solve a problem or explain a phenomenon.

Have you posed an authentic problem or significant question that engages students and requires core subject knowledge to solve or answer?

Geospatial Analysis Framework

Which types of geospatial analyses will students conduct to find relationships and patterns in order to develop conceptual understanding?

Check all that apply:

- ☐ Finding where things are (in relation to other things)
- ☐ Finding what's nearby
- ☐ Examining what's inside
- ☐ Comparing most and least
- ☐ Finding areas of concentration (density)
- ☐ Examining change over time

For each item checked above, what will students analyze, compare, and/or interpret (not specific datasets, but big ideas)?

STOP HERE FOR SESSION 2. YOU WILL COMPLETE THE REST OF THE TEMPLATE IN OTHER SESSIONS.

Evidence of Student Learning

Define the student products for the Geospatial Inquiry-enhanced lesson/unit.

Which of these (or other products) will you assess? Which products require feedback to enable students to refine their thinking?

Early on (diagnostic):

In the middle (formative):

Final product (summative):

Do students have <u>*multiple*</u> *opportunities to ask questions, analyze and interpret geospatial data, argue from evidence, present their arguments, and revise their thinking?*

Consider ways to assess content knowledge and skills, communication skills, and process. Consider both formal products and informal assessments (conversations, observations, etc.).

Quality of Evidence

State the criteria for exemplary performance for each product:

Product:

Criteria:

Product:

Criteria:

Product:

Criteria:

Do the products and criteria align with identified outcomes? Do the products and tasks give all students the opportunity to demonstrate what they have learned not only through visual representations, but also through writing and speaking? Do assessments enable you to determine <u>how well</u> a student understands? Do formative assessments reveal student thinking behind mistakes so you can intervene?

Examine Geospatial Data

What maps or data could students explore to spark questions and engage them in the investigation? Is a video or news story appropriate to introduce these maps or data? Is there a career connection that could be embedded?

Map the Geospatial Inquiry

You have defined the problem or question and the student products for a Geospatial Inquiry-enhanced lesson/unit above. What knowledge and skills do students need in order to make the decision, explain the phenomenon, or answer the guiding question? What additional learning activities (hands on investigations, readings, etc.) must be completed to accompany the Geospatial Inquiry in order to help students explain the reasoning for their claims, why this phenomena occurs, or why the geospatial evidence is relevant?

Please describe the major activities for the entire lesson/unit, before, during, and after the Geospatial Inquiry, as appropriate.

Activity Description	**Learning Goal**	**How it helps students address the guiding question**

Identify activities which require scaffolds for writing or participation.

Activity	**Type of Scaffold**

Have you identified opportunities to promote productive talk?

What challenges or problems might arise in this Geospatial Inquiry-enhanced lesson/unit? How will you overcome these challenges?

2 CAREER SPOTLIGHT

Summary

The **Power of Data (POD)** project hopes to improve student interest, awareness and attitude toward STEM careers. There are a wide variety of geospatial technology (GST) career opportunities for young people to consider as a possible profession. The career spotlight pieces are stories from interviews with real people in GST careers. Each of these spotlights presents an opportunity to share with students the many types of careers available in this field.

Goals

- Experience a diversity of careers that use geospatial technologies
- Discover how professionals in STEM fields engage in Geospatial Inquiry and for what purposes
- Consider how STEM Professionals' work is similar to the Geospatial Inquiry in the POD Teacher Workshop, and the Geospatial Inquiries in which students might engage
- Consider how to introduce geospatial careers to students and inspire them to enter these fields

While watching the video, consider:

- How does Rohini use the steps of Geospatial Inquiry in her work?

- How could you use this piece with your students to inspire them to pursue a STEM career?

Rohini Swaminathan -
Rohini Swaminathan is a Geomatics engineer working with UNOSAT, the Operational Satellite Applications Programme of UNITAR, the United Nations Institute of Training and Research based in Geneva, Switzerland. She also trains local decision-makers in Asia and Africa on systems to *reduce disaster-related risks in Bangladesh, and countries in East Africa.*

"It all started when the tsunami happened in India when I was 15. My dad was working with fisherman there and we were living not living far away from the coast. I went with my dad to go see what happened. We had never heard the world "tsunami" before. No one really understand that an earthquake happened or that there could have been an early warning system to prevent the disaster."

-Rohini Swaminahthan

WATCH Rohini's TED X Talk

"There is nothing natural about disaster"

https://www.youtube.com/watch?v=h7fbfZxoWlY

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2 METACOGNITION

Goals

- Engage in reflective practice:
    - Review Science and Geospatial Technology learning from the session
    - Contemplate how Geospatial Inquiry enhanced individual learning
    - Consider ways to use Geospatial Inquiry in a classroom to enhance student learning

Geospatial Inquiry is **socially constructed**. It provides opportunities to collaborate, compare ideas, and receive feedback on those ideas through productive, equitable and respectful discourse (talk). How did working with others influence your learning today? What specifically contributed to your learning (another participant, specific materials or activities, the facilitator)? How might your learning have been influenced if you had worked alone?

Geospatial technologies are **tools** to **critically analyze and interpret patterns and relationships** in geospatial data and to create visual evidence to support written arguments. How did you use these tools to enhance your learning today? What did you learn?

What are you still struggling with?

<u>Focus on Geospatial Analysis Frameworks</u>

In this session, you experienced Geospatial Inquiry as a learner. You conducted geospatial analyses including "*Finding what's nearby*" and "*Examining most and least*". You also considered how geospatial analyses can influence decisions. What are some concepts you currently teach that could be enhanced with geospatial analyses?

Finding what's nearby:

Examining most and least:

How might the results of these geospatial analyses influence important decisions in your discipline?

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2 SCIENCE REVIEW

2.1. Factors that contribute to EQ damage, and that complicate post-EQ response

The scale used to describe earthquake magnitudes today is the ***moment magnitude*** scale. Previously, earthquakes were most commonly quantified using the Richter scale. Both are logarithmic. For example, an earthquake with magnitude 6 would show waveforms on the seismogram that have amplitudes ten times that for a magnitude 5 earthquake. In other words, ten times greater shaking would be observed at the ground for the magnitude 6 earthquake. A jump in magnitude of 1 unit corresponds to an increase in energy release of more than 33 times, however. That is because in larger earthquakes there is both a greater amount of shaking, and the rupture affects a larger area of the fault plane. The ***moment magnitude*** scale is symbolized as "Mw". The "w" denotes that the magnitude is based on the amount of mechanical work done (***energy released***) by the earthquake. The mathematical expression for moment magnitude is:

$$M_w = \frac{2}{3} log_{10}(M_0) - 10.7$$

where M_o is the seismic moment, which is the product of the rigidity of the faulted rocks, the total amount of slip, and the area of the fault that slipped during the earthquake. Because there is some uncertainty in the estimates of fault slip and area, sometimes published moment magnitudes for large earthquakes will vary slightly.

The typical ***magnitudes*** of the largest earthquakes are ***related to plate-boundary type***. The most powerful earthquakes occur at ***convergent*** boundaries. The largest ever measured was a Mw9.5 along the Chile Trench just west of South America in 1960 at a depth of 25 km. All five earthquakes in the past 50+ years with Mw≥9.0 have occurred in subduction zones. In fact the 33 largest recorded earthquakes have all happened at convergent plate boundaries. Two occurred in Alaska, and there is good evidence from the geologic record that a Mw~9 earthquake occurred in 1700 along the Oregon-Washington margin in the Cascadia subduction zone. It likely generated the tsunami that is famously captured in a Japanese painting. Tsunamis can travel across large ocean basins and cause serious damage thousands of kilometers from the epicenter.

The largest earthquakes at ***transform*** boundaries tend to range between Mw7 and Mw8, although a few larger ones have occurred. The 1906 Mw7.8 earthquake that devastated San Francisco ruptured the San Andreas fault along a length of 430 km.

Earthquakes typically occurring along ***divergent*** plate boundaries have magnitudes less than 7. There have been a recorded few larger than this, but since divergent margins generally are far from land and populous areas, they rarely create a hazard.

There are several factors that contribute to the amount of ***damage*** from an earthquake. There is generally an ***inverse correlation between distance*** from the hypocenter and the amount of ***damage***. As earthquake waves pass through Earth materials, their energy dissipates. This applies to the depth of the earthquake as well – the deeper the earthquake, such as can occur at subduction zones, the less damage will result at the surface. The type of Earth material at the surface where the shaking occurs also controls damage. Loose, unconsolidated sediment or soil can amplify ground shaking, especially if the material is saturated with water. This is the process called ***liquefaction***.

Liquefaction produced a lot of damage in the Marina District of San Francisco during the Mw6.9 Loma Prieta earthquake of 1989, even though the epicenter was ~ 100 km to the south. Ground shaking and damage can be mapped by post-earthquake responders to produce a map of ***Modified Mercalli Intensity Scale*** values. The scale ranges from I (felt by only a very few) to XII (damage nearly total; objects are thrown up into the air

Sometimes subduction-zone earthquakes result in vertical motion of the seafloor that causes a tsunami. Tsunamis can result in sudden, temporary flooding of coastal areas up to several tens of meters in elevation and several kilometers inland. Tsunamis are most destructive closest to the epicenter but can travel thousands of kilometers across large ocean basins.

Common Ideas

Incorrect	***Correct***
An increase in earthquake magnitude of 1 results in a factor of 10 energy release.	An increase of earthquake magnitude of one results in an amplitude of shaking of 10. However, the total energy released is a function of amplitude of shaking and the area of fault rupture. Bigger earthquakes rupture larger fault areas, and the energy increase is >33X for an increase of one magnitude.
The amount of shaking and damage is the same for the same size earthquake.	The intensity of shaking at the surface can vary a lot depending on the physical properties of the material through which the waves travel. The amplitude of shaking can be much greater in loose, unconsolidated sediment compared to hard bedrock.

Summary

- Earthquake magnitudes are commonly reported on the moment magnitude scale, which combines the strength of the rock faulted, the amount of slip, and the area of fault rupture.
- Moment magnitude describes the amount of "work" done by an earthquake by combining the area of fault rupture and integrating the amount of slip over the entire fault surface.
- An increase of 1 unit of magnitude results from a 10 times increase of ground shaking; the amount of energy release increases by ~33 times because the area of rupture is much greater.
- The largest earthquakes occur at convergent plate boundaries; large, hazardous earthquakes also occur at continental transform boundaries.
- Divergent boundaries generally have the smallest maximum earthquake size and are typically located farthest from population centers.
- Factors that contribute to damage from earthquakes are magnitude, distance to the hypocenter (including depth), the type of Earth materials undergoing shaking, and the type of construction used in buildings.
- Liquefaction can occur during ground shaking and can be particularly damaging.
- Ground shaking can be quantified using the modified Mercali scale.
- Tsunamis are rarer than large earthquakes and are most likely to occur at convergent boundaries.

2 GEOSPATIAL TECHNOLOGY SKILLS REVIEW

In session 2 you explored and organized data in several ways. First, you viewed the data in the table by sorting a column in ascending and descending order. You then filtered the data in the table by one variable (e.g. Earthquake Magnitude) and selected features in the table. Viewing data in the table is a good way to quickly see the lowest or highest values in your data.

After exploring the data in the table, you symbolized and thematically mapped the data by changing the style of the earthquake symbols by depth (color) and magnitude (size). Using colors to represent your numerical or ranked data, such as earthquake depth, can show a trend. For example, a cluster of darkly colored deeper earthquake points along a plate boundary may indicate that the coincident plate boundary is convergent. On the other hand, using different symbol sizes to represent your numerical or ranked data, such as magnitude, simply shows the larger the symbol, the bigger the data value.

In the next activity, you reduced the actual data size by applying a filter. This is a quick way to use ArcGIS Online to make a dataset smaller so as to speed up analysis operations. Using the analysis tools "Use Proximity" and "Find Nearest" you were able to find earthquakes that were within the proximity of or nearest to surrounding cities. Once again, you were then able to use the table to view the average in the table statistics of the analysis computations.

Finally, to present your argument using geospatial data as evidence, you created and ran a presentation of your map exploration and findings. The ArcGIS Online presentation tool allows you to save various positions and zoom levels of your map into "slides" while annotating those slides with text. This is just one method to present the geospatial evidence you have gathered.

To review any of these skills, please reference the ArcGIS Online Task Cards in the front of your Teacher Guide. Also, see http://www.pod-stem.org/more/

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2 HOMEWORK: PEDAGOGICAL MOVES TO PROMOTE GEOSPATIAL INQUIRY – ESTABLISHING A CULTURE OF PRODUCTIVE TALK

Designing a Geospatial Inquiry	Geospatial Inquiry	Career Spotlight	Metacognition & Homework

Summary

In this homework, consider what teachers must do to ensure their classroom norms and culture and promote academically productive talk. View videos of classrooms and reflect on what we have done in the workshop so far that promotes academically productive talk.

Goals

- **Geospatial Inquiry** requires **structure** to promote a **culture** of **collaborative learning**:
    - Consider ways to establish a culture that supports academically productive talk
    - Reflect on what we have done thus far in the Workshop to promote this culture
    - Consider implications for your unique context

Think about a learning experience

Think about a learning experience that encouraged a culture of academically productive talk and one that was not as effective. What norms were in place that made the talk productive? What hindered academically productive talk?

RECORD YOUR THOUGHTS AS YOU VIEW THE FOLLOWING VIDEOS

(approximately 10 minutes for all six videos)

https://inquiryproject.terc.edu/prof_dev/resources/video_cases/video_case.cfm%3Fcase_type=tp&case_num=3&case_return=library.html

Valuing student talk

Set norms and expectations

Clarify expectations

Reinforce expectations

Include all students

How long does it take?

Culture in the POD Workshop

What have facilitators implemented to promote or hinder academically productive talk in the POD Workshop thus far? How have these affected your learning? Provide specific examples.

What do you currently do to support academically productive talk? What can you improve?

SESSION 3 POD TEACHER GUIDE

Session 3 at a Glance

Geospatial Inquiry	Implications for Teaching with Geospatial Inquiry	Career Spotlight	Designing a Geospatial Inquiry	Pedagogical Moves	Metacognition & Homework

Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

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3 GEOSPATIAL INQUIRY

Summary

In small groups, develop a risk determination for one of three cities. Use your previous analyses of earthquake characteristics and factors and ACQUIRE and ANALYZE ADDITIONAL DATA about the human systems impacted by these events. Present your findings to one another through a jigsaw presentation. As a jigsaw group, make an overall determination as to which of the four cities is at most risk for experiencing a seismic disaster, present this information in a Story Map, receive peer feedback, and revise as needed.

Goals

Engage in **cross disciplinary practices**:

- **Collaboratively develop an argument** about a relationship in geospatial data for a defined purpose
- **Engage in argument** using geospatial data as **evidence** with appropriate **reasoning**
- **Communicate** an evidence-based argument to an audience, receive feedback and revise as needed
- Engage in **academically productive talk** to further understanding of **big disciplinary ideas**

GUIDING QUESTIONS

Which regions of the world are most at risk of experiencing natural disaster?

I. How can geospatial data be used to help explain where and why natural hazards occur?
II. What patterns and relationships in geospatial data indicate high risk of disaster?
III. How can geospatial data and tools be used as evidence to communicate risk?

Geospatial Analysis framework

- Examining where things are
- Finding areas of concentration
- Examining most and least
- Finding what's inside
- Finding what's nearby
- Examining change over time

Summarize & Ask

ASK: What data do we need to make a risk determination?

Re-examine Representation #3, the Venn diagram illustrating Risk of Disaster ***(Handout 1A Terminology and Representation).*** Consider the data that we have already collected and analyzed and consider what other new data we still need in order to determine risk for your designated area.

Data we acquired & analyzed	What we learned from the data	What do we still need to know?	What data/information will we need to acquire?

Determine Seismic risk

Work with a partner or small group. Acquire, analyze, and interpret data about the natural system and the (human) vulnerable system. Add this to the data you have already analyzed on the risk of severe earthquakes to argue whether significant resources should be devoted to planning for or mitigating the effects of earthquakes in one of the following cities:

1. Los Angeles, USA
2. Tokyo, Japan
3. Reykjavik, Iceland

________________________ (Name of City)	
Data Category	Possible Search Terms

Searching for Risk Determination Data

1. Open a new map.

2. Choose one of the three example cities to analyze.

3. Zoom into the city and surrounding area that you are studying.

4. Add data layers to the map using the techniques learned on Days 1 and 2.

- When adding data to the map, use the search terms provided below to find the data layers suggested.
- When adding data using search terms, type in exactly as provided.
- Make sure the "In" box has ArcGIS Online chosen.
- Make sure the check box under the "In" field is checked. This will limit the search results to for data that includes only the area that you zoomed to.

5. When you search for data in ArcGIS Online, you should be mindful of the author (publisher of the data). All search terms provided in this activity should lead you to authoritative publishers who will maintain and continuously house the data for the long term. Other authors might be students or even people in the workplace who are temporarily creating the data. These data might be deleted or reconstructed at some point so you do want to be cognizant and read the metadata to obtain this information.

6. You can also click on Details for each layer in ArcGIS Online to see if it has the metadata fleshed out on it. The metadata should include a description of the data, data source.

7. Using analysis tools, analyze and interpret the data to answer the guiding question.

8. After completing your map, save and share with the POD-STEM organization.

Search Terms

Data Category	**Search Term**
Land use data (Explore AGO Living Atlas Landscape layers)	USA NLCD Land Cover GAP USA NLCD Landscape USA Cropland Land use Iceland - (Corine Land Cover Europe)
Emergency services	US HHS health resource locator
Transportation networks (Explore AGO Living Atlas Transportation and Urban Systems layers)	
Roads	
Railroads	Railroads – goods USA Railroads (Living Atlas)
Airports	Airports_Data
Ports – where do most goods come into the area	Major Seaports USA Shipping Fairways
Health Care (hospitals – location and when it was built)	Healthcare Facility California Surgical Clinic Healthcare Facility California GeneralAcuteCare
Food	US_Grocery_Stores_Esri
Fuel Pipelines	Mapping Our World Oil
Water pipelines	Hydrography - World
Population	Population Density USA Census Populated Places Esri Population World
Year of construction of buildings (the older the building the less likely it is to survive)	
Earthquake dataset	USGS Live Feed USA Earthquakes GlobalSeismographyNetwork
Miscellaneous (Explore AGO Living Atlas Layers)	Liquefaction Zones LA U.S. Department of the Interior - Current Global Natural Hazards USA Social Vulnerability

Argue from Evidence

Does your map present a coherent argument for your risk determination?
Consider the Argumentation Rubric categories *https://ldc-production-secure.s3.amazonaws.com/resource_files/files/000/000/091/original/Argumentation_Student_Work_Rubric_6-12_v_3.0.pdf*

Is there a **FOCUS** on the position/argument?

- Does the focus of the map address the prompt (related to risk determination)?
- Does the map present a convincing position or claim?

Is there a substantive **CONTROLLING IDEA**?

- Do the elements of the map clearly support the position or claim?

Is **RESEARCH** based in geospatial data analysis included?

- What types of data are included?
- Is there missing data (that either supports or contradicts the argument)?
- How is the data displayed or represented to support the argument?

Is the argument sufficiently **DEVELOPED**?

- Are appropriate and sufficient details provided?
- Does the data and information effectively support the claim (regarding risk determination)?

Present your Argument in a Story Map

Create a Story Map to present your findings from your risk determination investigation.

1. Open map

2. Click on the Share button

3. Make sure the Power of Data organization account checkbox is selected (Update Sharing on any data layers if the box pops up)

4. Click on Create a Web App:

    - Scroll down and click on Story Map Journal
    - Click on Create App
    - Complete the Title, Tags, and Summary fields
    - Click Done

5. Select the Side Panel or Floating Panel ("View a Live Example" for a sample of what each panel looks like and how it functions)

6. Click Start

7. Give your Story Map a name and click the right arrow

8. Click on the Select or Create a Map down arrow and select the map you created (If you have more than one map, choose the map you created prior to lunch)

9. On the Location line click on Custom Configuration

    - Zoom in to the area of study on your map
    - Click Save Map Location

10. On the Content line click on Custom Configuration

    - Turn on all layers you wish to show on this pane
    - Click Save Map Content

11. On the Popup line click on Custom Configuration

- Choose a popup that will be opened when the map is displayed
- If you have no popups you wish displayed on this pane, then skip Custom Configuration

12. Click Next

13. Add the text that you wish to display in the Side Panel that supports the map and the layers that are showing.

- Format using the text edit tools
- Add any links you have using the link button
- Add any video clips you might have found using the video camera icon

14. Click Add

15. Save your Story Map using the Save button in the top right corner

16. Click on Add Section on the bottom of the side pane

17. Type in the New Section Title (this is for the next "page" of your Story Map). In this pane, you can choose a Map, Image, Video, or Webpage. Complete this page of the Story Map using the same techniques learned above

18. Continue adding pages to your Story Map until you have presented your argument and results to the geospatial research you completed prior to lunch

You will present your Story Map for peer feedback.

Peer Feedback & Revision

While listening to your peer's presentation – use the categories from the argumentation rubric below to guide your feedback.

PRESENTATION (PEER FEEDBACK)			
ARGUMENTATION CATEGORY	FEEDBACK (answers to the questions)	EXAMPLE FROM PRESENTATION	SUGGESTIONS for IMPROVEMENT
FOCUS	Does the focus of the map address the prompt (related to risk determination)? Does the map present a convincing position or claim?		
CONTROLLING IDEA	Do the elements of the map clearly support the position or claim?		
RESEARCH	What types of **geospatial data** are included? Is there missing data (that either supports or contradicts the argument)?		

	How is the **geospatial data** displayed or represented to support the argument?		
DEVELOPMENT	Are appropriate and sufficient details provided? Does the data and information effectively support the claim (regarding risk determination)?		

Summary Table

Activity	**What we learned**	**How we learned it**	**How does this help us answer the guiding questions?**

3 IMPLICATIONS FOR TEACHING WITH GEOSPATIAL INQUIRY

Summary

We "jigsaw" interviews from teachers who have implemented Geospatial Inquiry to identify skills and dispositions that lead to successful facilitation of Geospatial Inquiry, the contexts in place that support Geospatial Inquiry, benefits of Geospatial Inquiry for students, and ways to overcome barriers.

Goals

- Explore aspects of well-facilitated Geospatial Inquiry:
    - Providing a **purpose** for engaging in Geospatial Inquiry
    - Planning Geospatial Inquiry over an appropriate amount of **time** to promote **conceptual understanding** of big disciplinary ideas
    - Providing multiple opportunities for students to **collaborate**, compare ideas, and receive **feedback** from peers, teachers, and stakeholders
- Highlight benefits of Geospatial Inquiry for students:
    - Geospatial Inquiry promotes **cross-disciplinary practices** and **21st century skills**
    - Engaging in Geospatial Inquiry and seeing how Geospatial Inquiry is used by professionals provides inspiration to enter **STEM careers**.

A – Characteristics and Contexts to Support Geospatial Inquiry

As you read, consider the following – How would you characterize this teacher? What are the contexts that support their use of Geospatial Inquiry?

Characteristics: What does this teacher believe about student learning? How does this teacher view his or her role as a teacher? What does the teacher do when faced with an obstacle? Why does the teacher use Geospatial Inquiry?

Contexts: Does this teacher have administrative support for Geospatial Inquiry? What kind of access to technology does the school have? Does the teacher have any partners?

Characteristics	Contexts

B - Benefits and Barriers to Geospatial Inquiry

As you read, consider the following – What are the benefits to students when implementing Geospatial Inquiry? What are barriers to Geospatial Inquiry?

Benefits	Barriers

Trends and Notes

Individual Reflection

What are some learnings that might help you as you implement your Geospatial Inquiry lessons? What barriers might you face? How will you overcome these barriers?

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3 Career Spotlight

Summary

The **Power of Data (POD)** project hopes to improve student interest, awareness and attitude toward STEM careers. There are a wide variety of geospatial technology (GST) career opportunities for young people to consider as a possible profession. The career spotlight pieces are stories from interviews with real people in GST careers. Each of these spotlights presents an opportunity to share with students the many types of careers available in this field.

Goals

- Experience a diversity of careers that use geospatial technologies
- Discover how professionals in STEM fields engage in Geospatial Inquiry and for what purposes
- Consider how STEM Professionals' work is similar to the Geospatial Inquiry in the POD Teacher Workshop, and the Geospatial Inquiries in which students might engage
- Consider diverse ways to introduce geospatial careers to students and inspire them to enter these fields

Jessica Block *is a Research Analyst at University of California San Diego specializing in the use of sensor networks, remote sensing, and geospatial visualization tools for disaster response, natural resource management, policy decision-making, and sustainability. She is an expert in the management and fusion of datasets from disparate sources, and uses visualization technology as the bridge between University research and the needs of community members. Her research in environmental sustainability has covered regions in the American West, Southeast Australia, Peru, and Mexico where growing populations depend on increasingly unstable resources in the face of climate change.*

What led you to become a geospatial career professional?

I remember being in high school and a teacher telling us, "Half of you are going to have jobs that don't' exist yet." That's exactly what happened for me and several of the folks I work with who are virtual reality designers. In high school I never would have said, "Hey, I want to do that!"

As a kid I considered myself an environmentalist. I was always wanting to be outside. But, I did not want to just be an advocate for the environment without understanding how it works. I spent my life trying to figure out how to help make a safer environment where we can breathe the air and we can live in harmony with our planet. I majored in Geology and took Urban Planning classes in college to learn the fundamentals of environmental science and planning. I also took part in an internship with the United States Geologic Survey (USGS) working on the Pacific Urban Corridor mapping project. The focus of the project was geologic hazards of the region and specifically how earthquakes, floods, and volcanoes might have an influence on the people who lived there. It was through this internship that I learned to use GIS and how to publish maps.

At some point, I decided I needed to know more about geomorphology; which is the study of how the shape of the surface of the earth changes from processes like rivers cutting mountains and mountains being built by earthquakes. I attended Arizona State University and completed a Masters Degree in geology. While I was there, I worked in a virtual reality facility. The goal of the facility was to give policy makers experiences to help them make informed decisions. For example, in order to know how best to make decisions about water resources, it is helpful to understand how drought is influencing different areas in different ways and how that may impact groundwater depletion in these areas.   I used GIS to create virtual reality geographic environments to give policy makers the opportunity to get a really good picture of what is happening with water resources in their area. It was a way to bring people together and have a common picture and visualization of what is happening using maps and GIS.

Working on the virtual reality project in Arizona led to a new opportunity in Australia. I worked on creating visualizations of the drought to better understand where water is in relation to where water is needed most. The drought was causing real strain on people, families and communities. Small farming families had lost millions of dollars from decades of drought. Australia had also experienced massive fires that led to the greatest loss of life due to fires, at that time more than any other place in the world.

The job in Australia led to yet another connection, this time in San Diego. I had colleagues who were working on mapping the 2007 wildfires in San Diego. We began talking about the technologies used to mitigate fire disaster and that led to me to my current job position at University of California San Diego.

What is a typical work day like for you?

Even though I was trained as a geologist, I work with professionals from many different fields. I work with engineers who design radio towers and mobile devices and together we research questions about how these types of technologies can be useful for disaster mitigation. One of these projects is the High Performance Research and Education Network (HPREN). The network uses high speed internet connections, web cameras, and weather sensors across San Diego County to monitor where fires break out and to alert about hazardous fire conditions before they happen.

I also work on public health projects looking at how our place in the environment can influence our health. I use GIS to understand these kinds of spatial relationships such as how people in high air pollution areas are more likely to have asthma, diabetes, and issues with obesity.

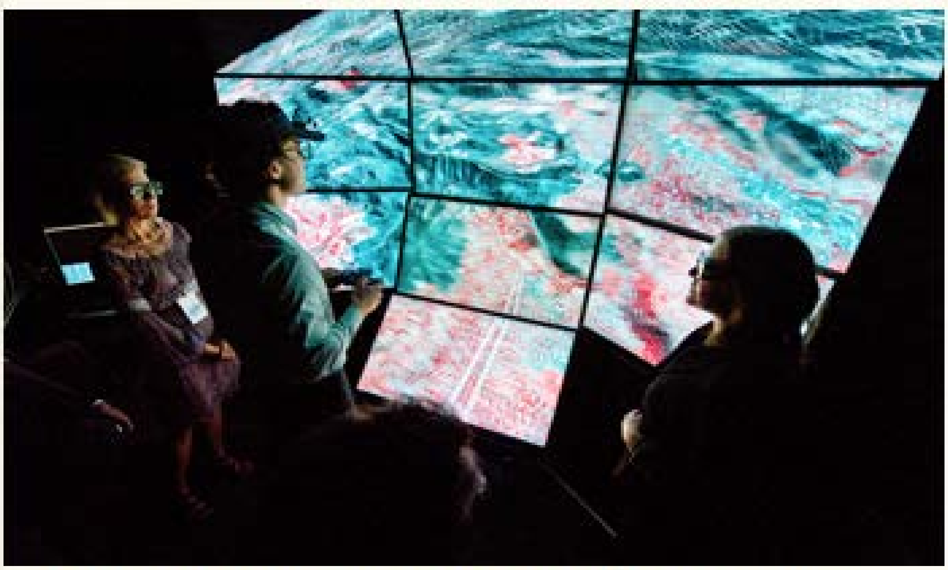
My work varies from day to day. Some days I just get to make maps or collect data from different web sites. For example, I might be working on making a map to figure out where vehicle traffic is in relation to instances of asthma. On other days I'm having meetings with stakeholders or people at my University or other Universities and talking about the kinds of things we want to work on together. Sometimes I'm visiting with companies that make it their business to collect data and make it available. I also spend chunks of time writing proposals for grants because that is how my job is funded. It takes a long time and is very competitive but it is also very exciting.

GIS is integral to what I do because we need to access, use, and share a lot of information. Some GIS software has a steep learning curve, but there are several GIS web mapping tools, many of which are free and easy to use. These tools allow our researchers in the field, who do not have extensive GIS training, to publish and share location specific data we can use for disaster monitoring.

What do you enjoy and find challenging about your position?

The field is always changing and that can be intimidating. I think it can be scary for anyone who is the first person in their family to go to college or if you were never exposed to the academic world. It can feel like you need to know everything. But, unless you are a robot it's impossible to learn everything.

You have to learn to be inquisitive and collaborative. What I like most about my job is that I'm part of a greater purpose where I'm influencing the world to become a greater place.



As part of a Tuesday evening program, Calit2 Research Scientist Jurgen Schulze (center) and Project Manager Jessica Block (right) demonstrate a 3D visualization of data taken from the 2007 wildfires in San Diego County in the Calit2 NexCAVE.

Discuss in small groups:

- How does Jessica use the steps of Geospatial Inquiry in her work?
- How does Jessica's work compare with Rohini's?
- How could you use this piece with your students to inspire them to pursue a STEM career?
- How does the interview format compare with the video format?

3 Designing a Geospatial Inquiry

Summary

Revisit your Geospatial Inquiry Template to consider what products you will assign students in order to a). provide feedback for revision and b). collect evidence of student learning throughout the Geospatial Inquiry. Then, identify criteria against which you can assess student products.

Goals

Continue planning for Geospatial Inquiry to supplement an existing unit:

- Identify opportunities for students to use technology to make sense of **relationships and patterns** in geospatial data and to create **visual evidence** to support written **arguments**.
- Identify an appropriately timed **sequence of activities** to promote conceptual understanding of big disciplinary ideas
- Identify opportunities for students to collaborate, compare ideas, and **receive feedback** on those ideas
- Define criteria to determine **evidence** of student **conceptual understanding**

Teaching for Conceptual Understanding

The next section of the Geospatial Inquiry Template asks you to identify student products that will serve as evidence of student learning throughout the unit.

It might be helpful for you to sketch out a sequence of smaller ideas that build toward conceptual understanding of the big idea before thinking about the products.

Refer to your Geospatial Inquiry Lesson Template you saved in Session 2. You identified learning goals. What is an appropriate sequence of smaller concepts that will guide students toward conceptual understanding? Sketch an outline below.

Big Idea from Session 2:

Concepts/sub concepts:

Specific Ideas:

Example

Big Idea:

Earth system processes in the atmosphere, hydrosphere and geosphere (natural hazards) become disastrous when they occur near densely populated areas, natural resources, or critical infrastructure (vulnerable systems).

Sub Concepts:

Natural hazards, Disaster, Risk, Vulnerable system, Predictability

Specific to Seismic Hazard Example:

Plate tectonics, boundaries, continental vs. oceanic crust, Seismic risk factors

Critical Junctures and Feedback

As students explore these smaller concepts, there are likely **critical junctures** or places where students must really understand something before they can move on. For example, in order to understand the risk of earthquakes becoming natural disasters, students need to understand the relationship between plate boundary interactions and earthquake magnitudes. They also need to understand the concept of vulnerable systems.

At those critical junctures, teachers must design opportunities which **make student thinking visible**. Students must create some kind of product or evidence of their learning at that juncture.

Students also need **feedback** on these products so they know if they can move forward, if they need to **revise** their ideas, or if teachers need to **intervene** with new learning experiences to help build student conceptual understanding.

Geospatial technologies are **tools** that support Geospatial Inquiry: to create **visual representations** which can be used as evidence to support written arguments.

We strongly suggest that each visual representation that serves as evidence for student learning is supported by a written or oral argument that is presented to peers for feedback and revision.

This has been modeled throughout our example Geospatial Inquiry on Hazard and Risk.

Return to **Evidence of Student Learning** on the Geospatial Inquiry Lesson Template. Note critical junctures and products.

Evidence of Student Learning

Define the student products for the Geospatial Inquiry-enhanced lesson/unit.

Which of these (or other products) will you assess? Which products require feedback to enable students to refine their thinking?

Early on:

In the middle:

Final product:

Do students have multiple opportunities to ask questions, analyze and interpret geospatial data, argue from evidence, present their arguments, and revise their thinking?

Consider ways to assess content knowledge and skills, communication skills, and process. Consider both formal products and informal assessments (conversations, observations, etc.).

For each product identified, delineate **criteria** for success under **Quality of Evidence**. Note you'll revisit this criteria in Session 4.

Quality of Evidence

State the criteria for exemplary performance for each product:

Product:

Criteria:

Do the products and criteria align with identified outcomes? Do the products and tasks give all students the opportunity to demonstrate what they have learned not only through visual representations, but also through writing and speaking? Do assessments enable you to determine how well a student understands? Do formative assessments reveal student thinking behind mistakes so you can intervene?

STOP HERE FOR SESSION 3. YOU WILL COMPLETE OTHER SECTIONS OF THE TEMPLATE IN SESSIONS 4 AND 5.

3 PEDAGOGICAL MOVES TO PROMOTE GEOSPATIAL INQUIRY – HOW TO SUPPORT PRODUCTIVE TALK

Summary

We discuss what it takes to promote a culture of academically productive talk, then consider some specific teaching strategies. We introduce Talk Moves aligned with goals related to different steps in Geospatial Inquiry and view classroom videos of these Talk Moves in action.

Goals

Provide opportunities for teachers to:

- Consider **structures** which promote a **culture** of **collaborative learning** in the **Geospatial Inquiry**
- Explore teaching strategies (Talk Moves) which support academically productive talk in real classrooms

As you read the Talk Science Primer *Example of a Productive Science Discussion*, consider what the teacher is doing to promote academically productive talk. How might you use these Talk Moves to promote academically productive talk during a Geospatial Inquiry?

Talk Moves

Goal 1: Help students share, expand, and clarify their own thinking

Goal 2: Help students listen carefully to one another

Goal 3: Help students deepen reasoning

Goal 4: Help students think with others

Videos of these Talk Moves in action are available for viewing at: https://inquiryproject.terc.edu/prof_dev/library.cfm.html > Talk Strategies (Talk Moves)

All videos can be found by visiting this library of resources

https://inquiryproject.terc.edu/prof_dev/library.cfm.html

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3 METACOGNITION

Goals

- Engage in reflective practice:
  - Review Science and Geospatial Technology learning from the session
  - Contemplate how Geospatial Inquiry enhanced individual learning
  - Consider ways to use Geospatial Inquiry in a classroom to enhance student learning

How did Geospatial Inquiry help your learning today?

What are you still struggling with?

Geospatial Inquiry promotes **cross-disciplinary practices** and **21st century skills (collaboration, communication, critical thinking, and creativity)**. Beyond the steps of Geospatial Inquiry, in what other important practices or skills from other disciplines (e.g. history, geography, mathematics, language arts, etc.) did you engage?

Focus on Geospatial Analysis Frameworks

In this session, you experienced Geospatial Inquiry as a learner. You conducted geospatial analyses including "*Finding what's nearby*" and "*Examining areas of concentration*". You also considered how geospatial analyses can influence decisions. What are some concepts you currently teach that could be enhanced with geospatial analyses?

Finding what's nearby:

Examining Areas of Concentration:

How might the results of these geospatial analyses influence important decisions in your discipline?

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3 Science Review

3.1. Factors that put populations at risk from earthquakes

When planning for earthquakes, it is important to consider the location of the population centers relative to active faults and plate boundaries. The location of active faults can be obtained from geologic maps for an area, published by state and national geological organizations. This information should also provide estimates of the largest-magnitude likely to occur and how often large earthquakes are likely to occur (the ***repeat*** or ***recurrence interval***). The US Geological Survey Earthquakes Program provides this kind of information for seismically active regions (http://earthquakes.usgs.gov).

There are additional factors to consider that can vary from region to region. These include: the population density; the rigor of seismic building codes and enforcement; the types of Earth material underlying populated areas; the types of building construction; and how susceptible important infrastructure is to damage from earthquakes.

3.2. What kinds of EQ education and preparedness steps can be taken to mitigate EQ effects?

The following is a list of steps that can be taken by city and county planners to reduce the damage and human injuries or death during and after a major earthquake. More information is available from the US Geological Survey (http://earthquake.usgs.gov/learn/publications/).

- Education, including EQ disaster drills, provide information about how to plan for the event and makes the public more aware of the risk
- Mapping of known active faults and age dating of past large earthquakes provides knowledge for zone and event frequency
- Early-warning networks can sense large earthquake waves and send warnings through cell phones, allowing people to seek safe shelter before the waves arrive
- Emergency supplies can be widely distributed and stored, including nonperishable food, water, tents, medical supplies, reinforced shelters, etc.
- Establish building codes for earthquake-resistant structures and enforce the codes
- Fund retrofitting of important structures, such as hospitals, fire and police, command and control centers, schools, essential cultural sites, high-density housing
- Retrofitting key transportation corridors: harbors, railways, airports, freeway interchanges
- In coastal areas, install tsunami awareness signs, establish an early-warning network, provide education about how to avoid tsunamis, and provide tsunami-resistant refuges

Common Ideas

Incorrect	*Correct*
Scientists can predict the time and day of earthquakes with reasonable certainty.	Scientists can forecast the statistical likelihood of an earthquake occurrence based on the history of earthquakes in an area.
There is nothing we can do to prepare for earthquakes.	Many government agencies can provide advice for how to be prepare for an earthquake. These include measures like stockpiling food and water for a minimum of three days, making homes and businesses safer by seismic retrofitting, becoming aware of early-warning systems in your area if available, establishing a contact point with relative well away from the likely affected area. More information is available from web sites such as the Red Cross (http://www.redcross.org/get-help/prepare-for-emergencies/types-of-emergencies/earthquake#Before-an-Earthquake).
Only people living in states on the west coast need to be ready for damaging earthquakes.	Damaging earthquakes have occurred in 46 of the 50 states.

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3 GEOSPATIAL TECHNOLOGY SKILLS REVIEW

In session three, you chose one of three example cities to analyze for earthquake risk using techniques you were exposed to in sessions one and two. You were provided with specific search terms to aid in successful data layer searching. When adding data to the map, you used the exact search terms provided to find the data layers suggested thus streamlining finding the specific data. This is a technique that will be helpful for beginning ArcGIS Online GIS users.

After creating your map with the data layers you chose, you used analysis tools based on the geospatial analysis framework (what's nearby, what's inside, etc.) to analyze and interpret the data to answer the guiding question.

You saved and shared your map to the POD organization and created a Story Map Journal to present your map to course colleagues. The various Story Map templates are another graphic way to present your geospatial evidence and is a good way to disseminate the information to the public because they are accessible via any web browser.

To review any of these skills, please reference the ArcGIS Online Task Cards in the front of your Teacher Guide. Also, see http://www.pod-stem.org/more/

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3 Homework: Review Natural Hazard Data

NOTE: there is no new science presented in sessions 4 and 5.

However, you will choose a NATURAL hazard and consider its potential to become a disaster in a defined region. Spend some time looking at the data and resources available for your Geospatial Inquiry. Don't spend too much time; we will revisit these in Session 4.

- The following is a partial list of resources for information about other kinds of natural disasters that might be useful in planning for Session 4.
  - Extreme weather
    - https://www.ncdc.noaa.gov/climate-information/extreme-events
  - Climate
    - https://www.ncdc.noaa.gov/climate-monitoring/
  - Colorado River drainage basin
    - https://www.usbr.gov/
    - https://www.nae.edu/Publications/Bridge/55183/55194.aspx
  - Hurricanes
    - http://www.nhc.noaa.gov/
  - Flooding
    - https://water.usgs.gov/floods/
  - Fires
    - http://www.firescience.gov/

- When considering potential for natural disaster, you will also consider the vulnerable system. Explore these data:
  - Buckets of Data - https://docs.google.com/spreadsheets/d/199sS0hj9-Mmn5PvWTGv1WrMmj9O0rpUc5PVYlNruizc/edit#gid=0

  Some of the vulnerable systems data provided in this list include:

  - Extreme temperature
  - Precipitation
  - Climate
  - Weather U.S. focused data here
  - Colorado River drainage basin (Water usage and how it's changed over time – How do you solve that problem or is there a solution)
  - Drainage basin
  - Water data
  - Hurricanes – Land value data, race, demographics,
  - Flooding
  - Elevation
  - Surface – impervious surface how much development over time
  - Population density
  - Drought
  - Fires
  - Vegetation – types
  - Development
- Finally, take a peek at all the amazing data available in Esri's Living Atlas.

  https://livingatlas.arcgis.com/en/#s=0

SESSION 4 POD TEACHER GUIDE

Session 4 at a Glance

Geospatial Inquiry	Implications for Teaching with Geospatial Inquiry	Career Spotlight	Pedagogical Moves	Designing a Geospatial Inquiry	Metacognition and Homework

Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

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4 GEOSPATIAL INQUIRY

Summary

You will work with your group to review the data available in the buckets of data document and Esri's Living Atlas. Based on your review, you will choose a hazard to investigate and a particular region to focus on. Your task is to determine if that region is at risk for disaster from the hazard you identified. Then you will create a presentation (using geospatial data) to communicate your findings as to whether significant resources should be devoted to planning for or mitigating the effects of the hazard.

Goals

Engage in **cross-disciplinary practices** and **21st century skills**:

1. **Collaboratively ask questions** and **critically analyze and interpret** geospatial data for a defined **purpose**
2. **Creatively select and display** appropriate geospatial data as **evidence** to support an **argument**
3. **Communicate** an **evidence-based argument** to an audience, receive feedback and revise as needed

GUIDING QUESTIONS

Which regions of the world are most at risk of experiencing natural disaster?

I. How can geospatial data be used to help explain where and why natural hazards occur?
II. What patterns and relationships in geospatial data indicate high risk of disaster?
III. How can geospatial data and tools be used as evidence to communicate risk?

Geospatial Analysis Framework

CONSIDER which of the GEOPATIAL ANALYSIS frameworks you will use

- Examining where things are
- Finding areas of concentration
- Examining most and least
- Finding what's inside
- Finding what's nearby
- Examining change over time

Apply your understanding of the relationship between vulnerable systems and natural hazards to determine the risk of natural disaster for a particular region.

Ask Questions

What information do you need?	What data do you need to acquire?	How will you analyze and interpret the data?

Natural Hazard: ___________________________

City/Region of Focus: _____________________________

Audience __________________________________

Acquire & Analyze Data

Use your Data Chart to consider data categories and corresponding search terms you could use to acquire data in these categories.

Discussion of Scale:

When exploring data to solve your geospatial map question, you need to be aware of the scale of the map and as such the related data. For instance, if you have a question that is **global** in nature, you will need to portray the entire globe on the map. This would be considered a **small-scale map** because the **map area must be made much smaller to show the entire world**. Even though a small-scale map shows more area, it has to show much less detail.

If you have a question for an area such as a **county, city or even a neighborhood**, the area displayed on the map will be much smaller. This is considered a **large-scale map** because, though the area to be represented is smaller, the information portrayed is in much more detail. A much **larger amount of detail is possible** on a large-scale map because the area in question is much smaller than a global map.

NOTE: We encourage you to consider how you would go about a data search by completing the chart below. However, for the purpose of this inquiry, use the Buckets of Data at the appropriate scale provided: https://docs.google.com/spreadsheets/d/199sS0hj9-Mmn5PvWTGv1WrMmj9O0rpUc5PVYlNruizc/edit#gid=0

____________________(Type of Hazard)		____________________(Name of City)	
Data Category	Possible Search Terms	Data Category	Possible Search Terms

For more on analysis tools available to ArcGIS Online organization account users, visit: http://doc.arcgis.com/en/arcgis-online/analyze/perform-analysis.htm

Create a Deliverable to Argue from Evidence

Craft a well-written argument based on the data you have acquired and analyzed. Refer to page 3-9 for guidance.

Choose a deliverable to present your argument using geospatial evidence. Review the following deliverables and consider which one is the best fit for the information you are presenting and your intended audience. Choose the simplest tool for the job. https://doc.arcgis.com/en/arcgis-online/create-maps/choose-configurable-app.htm

- Story Maps
- Collect and edit data
- Compare maps and layers
- Display a scene
- Explore and summarize data
- Make a gallery
- Map social media
- Provide local information
- Route and get directions
- Showcase a map

Peer Feedback & Revision

Consider the assets and limitations of the chosen deliverable for the argument presented.

ARUGMENT USING GEOSPATIAL PRESENTATION/ DELIVERABLE (PEER FEEDBACK)			
Argumentation Category	Evidence from the Presentation /Deliverable	Assets & Limitations *of the Deliverable Format for Presenting the Argument*	Suggestions
FOCUS Does the presentation/deliverable maintain focus on a convincing position or claim?			
CONTROLLING IDEA: Do the elements of the presentation/deliverable clearly support the position or claim?			
RESEARCH: How is the geospatial data displayed or represented to support the argument using this presentation/deliverable?			
DEVELOPMENT Does the presentation/deliverable			

include sufficient details and information to support the argument?			

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4 IMPLICATIONS FOR TEACHING WITH GEOSPATIAL INQUIRY

Summary

First you will consider the difference between assessment and grading. Then you will jigsaw some readings about assessment, and consider ways to provide feedback that is helpful to students and provides opportunities for revision.

Goals

- Consider the importance of clear **expectations**, regular **feedback** and opportunities for **revision** in Geospatial Inquiry
- Consider the need for **scaffolds** to support student success
- Consider how planning an **iterative** Geospatial Inquiry lesson over time with opportunities for regular **feedback** can guide instruction and ensure student success

Assessment and Grading

What is the difference between assessing and grading?

Providing Valuable Feedback during Geospatial Inquiry

Read the following interview. As you read, consider how this might influence your Geospatial Inquiry Lesson. Highlight a few lines and be prepared to discuss why you highlighted these lines with your small group.

Cassie – We are still struggling with the evaluation thing. We were trying to use a rubric and it just it just didn't quite cut it for us last year and we're not quite sure how it is going to work this year. We are trying to balance things out. We had to just basically give up on the rubric because it didn't work.

We talked to the kids and we told them that we didn't like rubrics, and asked them what they thought about rubrics, and if they disliked them, to tell us what they didn't like about them. We tried to put all of our ideas together to make a better rubric.

The thing that was so weird is they didn't look at the rubric. It drove us nuts. So, after that effort, they didn't even pay attention to it in submitting their projects.

Ron –Some kids really excelled and some kids had really not done anything. What you get when you say, "this is what I expect at a minimum, here are the things that are deliverables as products, if you want more you have to demonstrate something special is going on" you really get a diverse entire gamut of incoming work, some that are excellent and some that are really poor.

Cassie – We saw a lot of kids copying each other's ideas. They were running around asking 'what did you do?'

Ron – the first problem was basically it is a minimum expectation thing. The rubric sets up a minimum expectation for the kids, this is what we need to see as a minimum and if you do that, then you got basically an average grade. It is good for the low-end kid to know what it is they HAVE to do. But it doesn't do anything to stimulate or make a good kid better. But when we said show us what you are truly capable of, and you can get a better grade…

Cassie – that approach really got great results out of kids. Saying, "This is bottom line, but if you want to impress us and get a high grade then show us what you can do." But you really have to say that up front because kids need to know how they are being evaluated and that's always the hard part and we were struggling with that last year.

This year we told them "show us your creativity and your creative thought." Then they kind of hunkered down and came up with off the wall kind of things. Kids were being original in their thinking and we wanted to reward that. It puts them in a competitive mode vs. cooperative mode. Everybody wants to be into cooperative learning and all of that, but we find we get the best products when they are competing against one another. We don't want it to be cutthroat, but we want it to be their own creative thinking.

When you put the little caveat on it that says, "now, impress me, and that will be worth more" that perks them up a bit. But the thing with a smart kid is that minimal compliance is of relatively little interest to them. They want to excel.

For example, we had a student who needed some data for his map, but it was just not available. But oh wow, he was determined to get this on his map. So we said, let's go find where it is on the map, and then you can digitize it as a polygon and introduce it to your map. Well the kid went nuts… he was just so excited to be able to include that in his thinking. The reward for that was his original thought that would be then recognized in the grading. But beyond that, he knew that he had done something that was not yet available elsewhere.

Ron – and he both got the feeling that he had really done something different and unique with the GIS analysis and he also incorporated something new and different into the environmental problem he was exploring, so he got gratification both in using the GIS and in learning the environmental science.

I think the idea of setting an expectation is good. So for instance, we will identify a 'deliverables list'. We want to see these things. Now, the skill with which you put that together, the quality with which you approach those expectations and anything above and beyond that, which provides insight and contributes to your analysis is beneficial.

We can help them constrain the problem so it is doable, or by saying, ok, what else can you incorporate to make this a well-developed problem? And then as they put it together, the ones that work really well get good grades and so the reward is the benefit of that grade.

So that type of approach seems to work better with many of our kids.

Record your thoughts following your small group discussion. How might this influence your Geospatial Inquiry Lesson?

Access online, read, and note key points of one of the articles.

1. Using Rubrics to Promote Thinking and Learning
   http://www.ascd.org/publications/educational-leadership/feb00/vol57/num05/Using-Rubrics-to-Promote-Thinking-and-Learning.aspx
2. Attributes of Effective Formative Assessment

   https://web.archive.org/web/20160417100159/https://ccsso.org/Documents/2008/Attributes_of_Effective_2008.pdf

Teach another person about what you read and learn about the second article.

Record your thoughts following your readings and discussion. How might this information influence your Geospatial Inquiry Lesson?

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4 Career Spotlight

Summary

Work in small groups to review career video(s), then compare how the workflow described in the pieces you reviewed compared to the steps of Geospatial Inquiry. Consider if and how these videos might inspire your students to enter STEM careers.

Goals

- Experience a diversity of careers that use geospatial technologies
- Discover how professionals in STEM fields engage in Geospatial Inquiry and for what purposes
- Consider how STEM Professionals' work is similar to the Geospatial Inquiry in the POD Teacher Workshop, and the Geospatial Inquiries in which students might engage
- Consider how to introduce geospatial careers to students and inspire them to enter these fields

Video Links

ESRI Video Examples

Disaster Preparedness at the New Madrid Fault (3:00)

One of the largest regional exercises in the U.S., CAPSTONE 14 involved eight states exercising their preparedness to respond to a catastrophic disaster. Built on an actual historical event, the scenario centered around a massive earthquake on the New Madrid Fault in the nation's heartland.

http://www.esri.com/videos/watch?videoid=pZLgsGokss0&channelid=UCJ203R9PsZn6wF_zYfsp1SA&title=esri-case-study:-capstone-14

Lalitesh Kattragadda: Making Maps to Fight Disaster, Build Economies (5:26)

As of 2005, only 15 percent of the world was mapped. This slows the delivery of aid after a disaster -- and hides the economic potential of unused lands and unknown roads. In this short talk, Google's Lalitesh Katragadda demos Map Maker, a group map-making tool that people around the globe are using to map their world.

https://youtu.be/p_p-Ex5KR4g

Walgreens Case Study (4:44)
Learn how Walgreens uses a strategic geo-centric approach to think locationally.

http://www.esri.com/videos/watch?videoid=4630&channelid=LegacyVideo&isLegacy=true&title=walgreens

Bay Area Rapid Transit (BART) Case Study (3:52)
Leaders at California's Bay Area Rapid Transit (BART) describe how they move 450,000 commuters a day, safely and efficiently with GIS.

http://www.esri.com/videos/watch?videoid=I_8trRIzPlk&channelid=UCZTiOg3n0pqUDSatq7mS2PA&title=esri-case-study:-bay-area-rapid-transit-(bart)

National Audubon Society Case Study (3:37)
The Audubon Society with State & Local Partners discuss their advanced collaboration for birds and for people.

http://www.esri.com/videos/watch?videoid=g8jVS19_1GA&channelid=UCZTiOg3n0pqUDSatq7mS2PA&title=esri-case-study:-national-audubon-society

YouTube Video Examples

Bill Davenhall: - Where you Live (9:25)

Where you live impacts your health as much as diet and genes do, but it's not part of your medical records. In this TEDMed Video, Bill Davenhall shows how overlooked government geo-data (from local heart-attack rates to toxic dumpsite info) can mesh with mobile GPS apps to keep doctors in the loop. Call it "geo-medicine."

https://www.youtube.com/watch?v=62cNtvx6P8E&feature=youtu.be

Bernhard Seefeld – History and Future of Mapping (13:48)

Google Maps is aiming to publish the world's most comprehensive map. In this video, Bernhard Seefeld talks about how this enterprise is evolving and shares his thoughts on who will be doing the mapping in the future and what is driving that.

https://youtu.be/qtv69GRizl4

Greg Anser: Ecology from the Air: What are our Forests Really Made Of? (13:50)

From the air, ecologist Greg Asner uses a spectrometer and high-powered lasers to map nature in meticulous kaleidoscopic 3D detail -- what he calls "a very high-tech accounting system" of carbon. In this fascinating talk, Asner gives a clear message: To save our ecosystems, we need more data, gathered in new ways.

https://youtu.be/qCrVpRBBSvY

- How do the steps of the Geospatial Inquiry process compare to the workflow of these individuals/organizations?

- Can you identify any of the Geospatial Analysis Frameworks in the work of these individuals/organizations?

- How could you use this piece with your students to inspire them to pursue a STEM career?

4 Pedagogical Moves to Support Geospatial Inquiry – Scaffolds

Summary

Effective Geospatial Inquiry requires thoughtful scaffolding to ensure student access to knowledge and equity of ideas and participation. Presentation of concepts, technology skills, communication (talk and writing), and participation structures must be scaffolded. Consider ways we have scaffolded skills and knowledge throughout the Geospatial Inquiry.

Goals

- Consider the **scaffolds** provided throughout the Geospatial Inquiry which supported writing, academically productive talk, technology use, and participation in learning during the POD Teacher Workshop

Scaffolding

For your assigned category, review the POD Teacher Guide and POD Teacher Workshop Agenda to identify specific examples of how/when we have scaffolded or supported the presentation of concepts, geospatial technology skills, academically productive talk, or argument from evidence. Record ideas on sticky notes. When prompted, join others with the same number to discuss ideas and record them on your assigned poster.

1. Geospatial Technology Skills
2. Science or Geospatial Concepts
3. Academically Productive Talk
4. Arguing from Evidence

Jot down ideas for your Geospatial Inquiry. Are there opportunities for you to scaffold knowledge and skills?

4 DESIGNING A GEOSPATIAL INQUIRY

Goals

- Continue planning for Geospatial Inquiry implementation to supplement an existing unit
- Consider feasibility of teaching this unit within 6 months of the POD Teacher Workshop with data that is available
- Ensure appropriate **technological and communication scaffolds** are included to support students
- Revisit formative and summative assessments to ensure students receive **feedback** on ideas as they build **conceptual understanding**

COMPLETED GEOSPATIAL INQUIRY EXAMPLE

Teacher POD Example

Grade level(s) Adult Learners

Subject(s) Earth and Environmental Science

Existing lesson/unit to be *enhanced* by Geospatial Inquiry Natural Hazards and Risks of Natural Disasters

Anticipated timeframe 10 hours

Anticipated implementation (month, year) Summer 2017

Begin with the End in Mind

What essential understanding will students gain from completing this Geospatial Inquiry-enhanced lesson/unit? A concept is an idea that can be applied in multiple contexts to explain and/or predict outcomes. Conceptual understanding is the ability to apply a big idea/concept in multiple contexts to explain and/or predict outcomes.

Earth system processes in the atmosphere, hydrosphere and geosphere (natural hazards) become disastrous when they occur near densely populated areas, natural resources, or critical infrastructure (vulnerable systems).

Studying past events can lead to better understanding of underlying causes and help predict risk of future events. Planning for mitigation and communicating risk to stakeholders can reduce effects of natural hazards on the vulnerable system and increase the system's ability to respond appropriately and recover quickly.

- Some hazards are preceded by phenomena that allow for reliable predictions and others occur with no notice. Mapping and history in a region combined with understanding geological forces can help forecast future events.
- There are several natural phenomena that can become hazards. Whenever they occur, life or property may be lost. However, not all areas of the world are impacted equally by these natural hazards.
- Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable forecasts of the probability of occurrence in a finite time period. Others, such as earthquakes, occur suddenly and with no notice, and thus they are not yet predictable. However, mapping the history of natural hazards in a region, combined with an understanding of related geological forces can help forecast the locations and likelihoods of future events. (ESS3.B 6-8)
- Natural hazards can be local, regional, or global in origin and impact, and their risks increase as populations grow. (ESS3.B 9-12)

Have you written a statement that allows students to apply a broad idea in multiple contexts to explain and/or predict outcomes?

Identify 2-3 key skills and/or cross-disciplinary practices students will learn or use during this Geospatial Inquiry-enhanced lesson/unit (e.g. collaboration, communication)

Critical thinking – analyzing and interpreting data to make claims based on geospatial evidence

Collaboration – working with others, participating in academically productive talk

Communication – arguing from evidence to a defined audience; participating in academically productive talk; displaying geospatial data in ways that make patterns evident

Which types of geospatial analyses will students conduct to find relationships and patterns in order to develop conceptual understanding?

For each item checked, what will students analyze, compare, and/or interpret (not specific datasets, but big ideas)?

Check all that apply:

X Finding where things are (in relation to other things)

For example: Locations of past major earthquakes in relation to plate boundaries and types of crust. For project of choice: locations of past natural hazard of choice in relation to factors that affect the natural hazard

X Finding what's nearby

Major cities, critical infrastructure, natural resources, critical facilities

- [ ] Examining what's inside
- [ ] Comparing most and least

X Finding areas of concentration (density)

For example: Of major earthquakes, of population. For project of choice: of natural hazard, of population.

- [ ] Examining change over time

Ask Questions

Craft a guiding question which provides a purpose for engaging in the Geospatial Inquiry-enhanced lesson/unit. The statement should encompass all content and outcomes and should require to answer a question, solve a problem or explain a phenomenon.

How can we predict if an area is at high risk for natural disaster?

- How can geospatial data be used to help explain where and why natural hazards occur?
- What patterns and relationships in geospatial data indicate high risk of disaster?
- How can geospatial data and tools be used as evidence to communicate risk?

Have you posed an authentic problem or significant question that engages students and requires core subject knowledge to solve or answer?

Evidence of Student Learning

Define the student products for the Geospatial Inquiry-enhanced lesson/unit.

Which of these (or other products) will you assess? Which products require feedback to enable students to refine their thinking?

Early on (diagnostic):

- Group consensus on definitions of hazard, risk, disaster
- Need to know, data to acquire charts

In the middle (formative):

- Evidence based arguments about the reasoning behind natural hazards (e.g. relationship of depth, magnitude, and intensity of earthquakes) presented in ArcGIS Online presentation (peer feedback and opportunity to revise)

- Evidence based arguments about the risk of natural hazards (e.g. major seismic event) in a particular region presented in ArcGIS Online Story Map (peer feedback and opportunity to revise)
- Academically productive talk with peers during activities (instructor intervention as appropriate)
- Academically productive talk with whole group during summary table discussions at end of each session (instructor intervention as appropriate)
- Academically productive talk with whole group during discussions of homework assignments/readings (instructor intervention as appropriate)

Final product (summative):

- Evidence based arguments about the risk of natural hazard of their choice in their region within a deliverable of their choosing based on intended audience (peer feedback and opportunity to revise)

Do students have <u>*multiple*</u> *opportunities to ask questions, analyze and interpret geospatial data, argue from evidence, present their arguments, and revise their thinking?*

Consider ways to assess content knowledge and skills, communication skills, and process. Consider both formal products and informal assessments (conversations, observations, etc.).

Quality of Evidence

State the criteria for exemplary performance for each product above:

Early on (diagnostic):

Product: Group consensus on definitions of hazard, risk, disaster
Criteria: n/a

Product: Need to know, data to acquire charts
Criteria: students identify need to acquire datasets from natural (e.g. plate boundaries, historic seismic events with attributes such as depth and magnitude) and vulnerable systems (e.g. population, infrastructure)

In the middle (formative):

Product: Evidence based arguments about the reasoning behind natural hazards presented in ArcGIS Online presentation

Criteria: Notes are present for numerous locations to reference patterns in the data. Claim should reference patterns in attributes of the hazards (e.g. relationship of depth, magnitude, and intensity of earthquakes; location and type of plate boundaries). Symbology should convey patterns in the data.

Product: Evidence based arguments about the risk of natural hazards (e.g. major seismic event) in a particular region presented in ArcGIS Online Story Map

Criteria: Claims should be illustrated with multiple examples of data from both natural (historic hazard data and magnitude of events) and vulnerable systems (population, infrastructure) and should draw upon prior claim about why natural hazard occurs in certain regions (e.g. convergent plate boundaries). Symbology should convey patterns in data and be supported by written arguments.

Final product (summative):

Evidence based arguments about the risk of natural hazard of their choice in their region within a deliverable of their choosing based on intended audience

Criteria: Hazard should be introduced with reasoning for choice and explanation of where this hazard occurs, why, how frequently, and whether it can be accurately predicted. Claims should be illustrated with multiple examples of data from both natural (e.g. historic hazard data and magnitude of events) and vulnerable systems (e.g. population, infrastructure). Symbology should convey patterns in data and be supported by written arguments. Potential mitigation or warning systems should be identified.

Do the products and criteria align with identified outcomes? Do the products and tasks give all students the opportunity to demonstrate what they have learned not only through visual representations, but also through writing and speaking? Do assessments enable you to determine <u>how well</u> a student understands? Do formative assessments reveal student thinking behind mistakes so you can intervene?

Examine Geospatial Data

What maps or data could students explore to spark questions and engage them in the investigation? Is a video or news story appropriate to introduce these maps or data?

- Anchor videos
- Global natural hazards from USGS “global earthquakes above 5.7”
- “Tectonic Plate Boundaries” from “Esri_TESS”
- “*World Volcanoes*” from “*Earth Science Atlas*”
- EarthquakesGlob_57
- TectonicPlateBoundaries
- USGS earthquake Hazards program and the National Seismographic Network
- Data buckets

Map the Geospatial Inquiry

You have defined the problem or question and the student products for a Geospatial Inquiry-enhanced lesson/unit above. What knowledge and skills do students need in order to make the decision, explain the phenomenon, or answer the guiding question? What additional learning activities (hands on investigations, readings, etc.) must be completed to accompany the Geospatial Inquiry in order to help students explain the reasoning for their claims, why this phenomena occurs, or why the geospatial evidence is relevant?

Please describe the major activities for the entire lesson/unit, before, during, and after the Geospatial Inquiry, as appropriate.

Activity Description	Learning Goal	How it helps students address the guiding question
Anchor video of impact from natural disaster	Provides a purpose for engaging in a Geospatial Inquiry	Introduces question: *How can we predict if an area is at high risk for natural disaster*? and *How can geospatial data be used to help explain where and why natural hazards occur?*
Consider definition of hazard, risk, disaster Consider need to know and data we need to acquire	Agree on common understanding of differences so we can engage as a learning community to answer the question; equity and access to ideas Invest in question and start to think about geospatial data as resources	We need to understand the difference and relationship between these terms before we can determine risk. This list of possible data can be expanded throughout the activities and serve as a resource when

		participants choose their own natural hazard to explore.
Examine global natural hazards data	Recognize relationships in spatial data by thinking about where things are in relationships to other things and find areas of concentration	Engaging in an example together will familiarize participants with a process and tools for analyzing and interpreting geospatial data and the factors that contribute to risk determination.
Craft evidence based arguments about where major seismic events occur, present to peers, receive feedback and revise	Argumentation from evidence, communication, evaluation, and reflection	Multiple opportunities to practice crafting and presenting evidence based arguments, providing feedback to peers, and revising based on peer feedback will ensure participants are prepared to succeed when they complete the investigation of their choice.
Lab stations (plate tectonics) and readings	Explore and better understand reasoning behind seismic events	Participants will gain practice with multiple tools for displaying variability and patterns in geospatial data and for communicating with geospatial data.
Examine relationships and	Recognize relationships in	Engaging in an example together will familiarize participants with a process

variability in earthquake data as it relates to plate boundaries Lab stations (plate tectonics) and readings Craft evidence based arguments about relationships, present to peers, receive feedback and revise	spatial data by finding what's nearby and examining most and least Explore and better understand reasoning behind seismic events Argumentation from evidence, communication, evaluation, and reflection	and tools for analyzing and interpreting geospatial data and the factors that contribute to risk determination. Multiple opportunities to practice crafting and presenting evidence based arguments, providing feedback to peers, and revising based on peer feedback will ensure participants are prepared to succeed when they complete the investigation of their choice. Participants will gain practice with multiple tools for displaying variability and patterns in geospatial data and for communicating with geospatial data.
Homework readings, pre readings, and lectures	Deepen geology content understanding	These readings and lectures can help participants better understand why earthquakes occur where they do. They may help participants explain why the geospatial evidence is relevant and/or explain the reasoning for their claims. They also provide equity and access to science ideas for all participants.
Examine vulnerable systems data	Recognize relationships in spatial data by	Engaging in an example together will familiarize participants with a process and tools for analyzing and

	finding areas of concentration and finding what's nearby	interpreting geospatial data and the factors that contribute to risk determination.
Craft evidence based arguments about risk, present to peers, receive feedback and revise	Argumentation from evidence, communication, evaluation, and reflection	Multiple opportunities to practice crafting and presenting evidence based arguments, providing feedback to peers, and revising based on peer feedback will ensure participants are prepared to succeed when they complete the investigation of their choice. Participants will gain practice with multiple tools for displaying variability and patterns in geospatial data and for communicating with geospatial data.
Determine the risk of choice of natural disaster in region of choice.	Demonstrate understanding of the relationship between vulnerable systems and natural hazards.	

Identify activities which require scaffolds for writing or participation.

Activity	Type of Scaffold
Crafting evidence based arguments	Claims, evidence, and reasoning framework; sentence stems: "I claim… If this claim is true, then when I examine the data I would expect to see…"
Academically productive talk	Role cards
Metacognition	Focus questions
Presenting	Literacy Design Collaborative protocols and rubrics https://ldc-production-secure.s3.amazonaws.com/resource_files/files/000/000/201/original/StudentWorkRubric-ArgumentationTask-Grades9-12.1.pdf
Providing peer feedback	Literacy Design Collaborative protocols and rubrics https://ldc-production-secure.s3.amazonaws.com/resource_files/files/000/000/201/original/StudentWorkRubric-ArgumentationTask-Grades9-12.1.pdf
ArcGIS Online Tasks: adding data, changing styles, using analysis tools, creating presentations	Task cards, online tutorials, ArcGIS Online Help

Have you identified opportunities to promote productive talk?

What challenges or problems might arise in this Geospatial Inquiry-enhanced lesson/unit? How will you overcome these challenges?

4 METACOGNITION

Goals

- Engage in reflective practice:
    - Review Science and Geospatial Technology learning from the session
    - Contemplate how Geospatial Inquiry enhanced individual learning
    - Consider ways to use Geospatial Inquiry in a classroom to enhance student learning

What did you learn today and how did you learn it?

What are you still struggling with?

Engaging in Geospatial Inquiry and seeing how Geospatial Inquiry is used by professionals provides inspiration to enter **STEM careers.** How might a Geospatial Inquiry experience inspire an interest in a STEM career?

4 Geospatial Technology Skills Review

During session 4, using the skills you learned from sessions one, two and three, you reviewed the data available in the POD organization account created for you by the POD team. These "buckets" of geospatial data have been aggregated from reliable sources and with appropriate scale for the area you have chosen to study in order to once again, streamline and aid in the process of answering a geospatial question.

With these data and the analytical tools available in ArcGIS Online, you chose the appropriate Esri app (e.g. ArcGIS Online Presentation, Story Map Journal, Explorer) to present your data.

To review any of these skills, please reference the ArcGIS Online Task Cards in the front of your Teacher Guide. Also, see http://www.pod-stem.org/more/

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4 HOMEWORK: CAREER SPOTLIGHT

Summary

In this homework, consider careers that use geospatial technologies.

Goals

- Explore diversity of careers that use geospatial technologies
- Explore educational pathways toward and salary ranges for these careers
- Consider how you might make students more aware of career opportunities in geospatial technologies.

Careers that utilize geospatial technologies

Explore the sites below. Note the diversity of careers that utilize geospatial technologies, including teaching geospatial technologies. Jot down some that interest you.

Department of Labor – Geospatial Careers - https://www.onetonline.org/find/quick?s=geospatial

Database of all occupations in the geospatial technology industry. Each occupation provides an economic outlook for the job, short description of the occupation and required skills and training, and an annual salary outlook.

American Association of Geographers - http://www.aag.org/careers

In their "Profiles of Geographers" you can read about individuals in different types of careers in education, business, government and non-profits.

What do you notice about skills and education necessary for these careers? Can you find any that require less than a four year degree?

How might you raise students' awareness of geospatial career opportunities?

SESSION 5 POD TEACHER GUIDE

Session 5 at a Glance

Implications for Teaching with Geospatial Inquiry	POD Resources and Research Overview	Designing a Geospatial Inquiry	Celebration	GST Post Assessment	Final Workshop Evaluation

Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

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5 Implications for Teaching with Geospatial Inquiry

Summary

Examine student work samples and reflect on important questions about teaching, learning, and assessment during a Geospatial Inquiry.

Goals

- Collaboratively examine student work to consider implications for teaching, learning, formative and summative assessment

Why Examine Student Work with Others?

When teachers take the time to collaboratively examine student work in depth, using structures which enable a focus on evidence, it can be a powerful way to inform and improve instruction that is truly student-centered.

This process, based on the Collaborative Assessment Conference (Seidel, 1998) and Making Sense of Student Work (Daehler & Folsom, 2014), requires teachers to collectively examine student work from a particular assignment in a structured way in order to help the group consider implications for future instruction and assessments.

A facilitator helps the group identify working agreements and set goals for the session. They then facilitate a systematic examination of work, asking questions and prompting the group to describe what they see and provide evidence for descriptions while withholding judgment.

After the group describes the work at face value, information about the student assignment and criteria for success is shared. This allows for discussion about implications for teaching and learning in the context of participants' classrooms.

Protocol

Choose a facilitator who will make sure the group stays focused on using evidence for claims. Set some working agreements such as staying on task, avoiding judgements, and being open to new ideas. Consider choosing roles such as timekeeper and recorder.

1. Examine the student work. (10 minutes)

Participants explore the work individually, recording what they notice. Participants might choose to sort the work based on patterns they see. They might also note questions they have about the assignment, the work, or that they would want to ask the student.

2. Describe the student work. (20 minutes)

The facilitator asks the group to describe the student work, including what they noticed (e.g. what ideas students seem to understand, places where they might be confused, or other items of interest). As the group shares, the facilitator asks participants to provide evidence for claims they make about the work. The group might begin recording themes that emerge.

3. Generate ideas about the assignment and intended learning goals for students. (10 minutes)

Participants generate ideas about the assignment that was given to students. The facilitator helps participants focus on evidence for their ideas, such as items and ideas that students emphasized in the work samples.

4. Examine the assignment and criteria for success. (5 minutes)

Participants individually review the assignment and assessment criteria that were provided to the students. They should note questions or items that were surprising or interesting.

5. Discuss implications for teaching and learning. (15 minutes)

The facilitator invites the group to share any ideas that may have surfaced in regards to their own classrooms. The facilitator should help the group focus on ideas teachers have about their own teaching moving forward as opposed to making suggestions to the teacher who shared the original student work and assignment.

Participants might discuss ways to address gaps in understanding/supporting student learning, ways to collect quality evidence of student learning via the types of assignments presented to students, and/or ways to communicate expectations of high quality work to students.

5. Think back upon the collaborative examination of student work. (10 minutes)

The facilitator asks the group to reflect on this process as a whole or parts of it. Was this process valuable? Why or why not? What worked well and what could be improved in future work together?

References

Daehler, K. & Folsom M. (2014). *Making sense of student work.* San Francisco: WestEd.

Seidel (1998). Collaborative Assessment Conference Protocol. Accessed September 23, 2017 from http://www.lasw.org/CAC_description.html.

NOTES

Research Kit for POD Teachers

Thank you so much for participating in the POD project! Your involvement is critical for expanding the knowledge base for improving the teaching and learning of new innovations. As part of your POD Teacher experience, you'll be submitting a variety of data for yourself and collecting data from your students. We've provided everything you need to collect these data and submit materials to your facilitator or the POD Team for analysis.

Kit Contents:

- Schedule for Teacher Data Collection
- Parental Notification Email Text – Survey Only
- Parental Notification Email Text – Survey & Observation
- Online Data Collection Links List

Schedule for Teacher Data Collection

Data must be collected at specific times during the POD Teacher Workshop and while implementing your Geospatial Inquiry lesson. The data collection schedule is presented below and based on when you participate in your POD Teacher Workshop and when you implement your lesson. A small subset of teachers will be selected for observation during the implementation of Geospatial Inquiry lessons. Scheduling of these specific times to observe will be negotiated between you and your POD Teacher Workshop Facilitator. All surveys will be sent from the email address PODSTEMNAU@gmail.com and any data to be returned by email should be sent to the same address. Please make sure you can receive email from this address.

POD Teacher Workshop

Time Point	Data to be Collected	Final Deadline	Who Submits	How	Completed
Selected to Attend	Memorandum of Understanding	Prior to Workshop	You	To Facilitator	
Selected to Attend	Teacher Stipend & Vendor Forms Photographic & Recording Release	Session 1 of Workshop	You	To Facilitator	
POD Workshop Session 1	Pre-GST Performance Assessment	Session 1 of Workshop	You	Online	
POD Workshop Session 1	Pre-Workshop Survey	Session 1 of Workshop	You	Online	
POD Workshop Session 5	Post-Workshop Survey	Session 5 of Workshop	You	Online	
POD Workshop Session 5	Post-GST Performance Assessment	Session 5 of Workshop	You	Online	
POD Workshop Session 5	Geospatial Inquiry Lesson Planning Template (uploaded with Post-Workshop Survey)	Session 5 of Workshop	You	Online	

Following POD Workshop	Disbursement of attendance stipend to you

Implementation of Geospatial Inquiry Lesson (MUST be implemented within 6 months of your POD Teacher Workshop)

Time Point	Data to be Collected	Final Deadline	Who Submits	How	Completed
Implement Geospatial Inquiry Lesson	Post-Lesson Student Survey	Final Implementation Session	Your students	Online	
Implement Geospatial Inquiry Lesson	Video-taped Observations (if selected)	During Implementation	Your facilitator	Mail	
Following Implementation of Geospatial Inquiry Lesson	Lesson Artifacts (if selected for video-taped observations)	Two weeks following implementation	You	Email	
Following Implementation of Geospatial Inquiry Lesson	Geospatial Inquiry Lesson Implementation Form	Two weeks following implementation	You	Online	
Geospatial Inquiry Lesson Completed	Stipend for implementation will be dispersed following receipt of Geospatial Inquiry Lesson Implementation Form (video-taped teachers will receive an additional stipend)				
6 months after POD Workshop	Post-Lesson Implementation Survey	7 months after POD workshop	You	Online	
6 months after POD Workshop	Post-Lesson GST Performance Assessment	7 months after POD workshop	You	Online	

Informed Consent & Research Responsibilities

You are responsible for implementing a Geospatial Inquiry lesson in your classroom and completing a Geospatial Inquiry Implementation Form within **6 months following your POD Teacher Workshop**. As part of this implementation you **MUST** notify parents of the research occurring in your classroom. We have provided the text required for either an email or note home to notify parents. You will administer a post-lesson survey to students following completion of your Geospatial Inquiry lesson. Students will be asked for their assent for participating in the research on the last screen of the student survey. Data from students who do not agree to participate in the research will be promptly deleted from the database by the POD Team. If parents want their student withdrawn from the study, they are asked to contact the POD Team. The student data will be promptly deleted from the database in this case as well.

If you have been selected for additional research, a Facilitator will be video-taping a lesson in your classroom. There is a slightly different parental notification that we have provided, but please know the video camera will focus on you and not your students during the video-taping of the lesson. Your POD Teacher Workshop Facilitator will be coordinating the time to video-tape these observations with you, please make sure you are in communication with them about the timing of your lesson.

Online Data Collection Links

We have provided a list of online data collection links and indicated if these will also be emailed to you by the POD Team from PODSTEMNAU@gmail.com. The list provides these links as a back-up in case there are any issues receiving email from the POD Team. We have also included a link to the teacher Geospatial Inquiry Lesson Implementation Form that you will complete within 2 weeks of implementing your lesson. Finally, we have provided the link to the Post-Lesson Student Survey for you to administer to your students.

Final Data Collection

Even though you will have already received your final stipend(s) we ask that you complete a post-lesson survey and a post-lesson GST performance assessment 6 months following your POD Teacher Workshop. These data are critical to the research project and will inform future professional development. It will help us to ensure funding for future programs such as this. Please complete these final assessments in a timely manner. Both will be sent to you from PODSTEMNAU@gmail.com .

Payments

You will be paid through Northern Arizona University (NAU). In order to pay you, you should have completed 3 stipend forms and 1 vendor form. The first stipend form is for attendance at the POD Teacher Workshop. The second stipend form is for submitting all of your data to NAU. The third stipend form will only be used if you are selected to participate in additional research, but we are asking all teachers to complete the form. Facilitators will submit these forms to NAU. **NOTE:** We are unable to pay stipends to non-US citizens or non-resident aliens.

You will be eligible for your first stipend after attending the POD Teacher Workshop and submitting the required data described in the POD Teacher Workshop table above. You will be eligible for second and third stipends as you complete and submit your data following implementation of a Geospatial Inquiry lesson in your classroom. If your data collection is complete and verified by the time points described below, stipend(s) will be submitted for processing. Processing takes up to 45 days. Actual payment will be received up to 45 days from dates listed below. For example, you could expect to receive a check by mid-September if your data were complete in August.

Payment Processing Schedule for Teacher & Facilitator Implementation Stipends:

- February 1, 2019
- May 1, 2019
- August 1, 2019
- November 1, 2019
- February 1, 2020
- May 1, 2020

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5 Designing a Geospatial Inquiry

Summary

Finalize your Geospatial Inquiry Template in light of the four sessions of learning. This session is intended to introduce resources and provide you time to plan how you will integrate Geospatial Inquiry into an existing class.

Goals

- Become familiarized with resources on www.pod-stem.org
- Compile a list of useful search terms from ArcGIS Online, Living Atlas, etc. for the Geospatial Inquiry lesson
- Curate geospatial data layers and maps students can analyze in the Geospatial Inquiry lesson in a personal folder on POD Organization Account

Teacher Resources

- Visit http://www.pod-stem.org/more/ to access Teacher Resources
- Visit http://www.pod-stem.org/teachers-lounge2/ to access this Teacher Guide online. The password is: begeospatial2

Mining Data from existing lessons:

- All items from Esri_GeoInquiry_EnvScience

http://education.maps.arcgis.com/home/search.html?q=owner:Esri_GeoInquiry_EnvScience

- All items from Mapping Our World
  http://www.arcgis.com/home/search.html?q=owner:MappingOurWorld
- All items from Esri_GeoInquiry_History

http://education.maps.arcgis.com/home/search.html?q=owner:Esri_GeoInquiry_History

- All items from Esri_GeoInquiry_APHG

http://education.maps.arcgis.com/home/search.html?q=owner%3AEsri_GeoInquiry_APHG&focus=all&restrict=true

- All items from Esri_GeoInquiry_Grade4

http://education.maps.arcgis.com/home/search.html?q=owner%3AEsri_GeoInquiry_Grade4&focus=layers

- GeoInquiries Customization Document

http://www.esri.com/geoinquiries > at the bottom find: The document titled "GeoInquiries customization – Tools for editing"
https://docs.google.com/document/d/12u4hKDT1HQpQYsoGpxifinM4JLPtO8Ql0hL8CbrE6vg/edit

Overview on ArcGIS Online Public and Organization Accounts

There is a lot that can be done with ArcGIS Online Public accounts for use in educational institutions. However, there is much more that can be accomplished through an ArcGIS Online Organization account, which are now available free to all K-12 institutions in the United States through the ConnectED program. The Organization account also may be the better way to go for schools who serve students under the age of 18 under the FERPA guidelines. Please check with your school administration.

An ArcGIS Online ***Organization*** account allows for:
-Unique secure logins
-Sharing control of maps, apps and documents within your organization
-More dataset choices
-More access to tools and applications
-Ability to create custom applications and Story Maps
-Ability to perform spatial analysis and data enrichment
-Custom portal for your organization

With an ArcGIS Online **Organization** account you can create and manage groups within the organization which allows for each user (teachers and / or students) associated with the organization to have their own "area" or "room" to conduct their projects with individual classes. Each user in the group can be managed with individual user privileges. Along with user privileges, ArcGIS Online for organizations also provides additional options for sharing maps that you or members of your organization (students or teachers) have created.

In an ArcGIS Online Public account there are only two sharing options that include public (everyone) or private (identified users). Using an ArcGIS Online Organization account you can choose to share with everyone (the world), share within the organization (your school or school district), or share with specified groups (individual classes or clubs) within the organization. You can also elect to keep the map private.

ArcGIS Online organization accounts allow for spatial analysis functions such as proximity, distance, find locations and density. There is also the ability to perform data enrichment which utilizes current demographic data to enrich data about certain locations. These tools provide and incredible amount of power to an online mapping platform that relies only on a web browser to run.

Along with the increased power of spatial analysis, there are more data options associated with the ArcGIS Online organization accounts. This "premium content" includes various Esri hosted searchable map layers and Esri Living Atlas layers, that are described as " the foremost collection of authoritative, ready-to-use global geographic information ever assembled. The themed content in the Living Atlas is curated from content available in ArcGIS Online. The Living Atlas enables the exploration of people and places around the world, as well as the natural and man-made influences that impact them. Always changing and evolving, like our world, the Living Atlas contains information that impacts lives". The Living Atlas contains datasets such as high resolution imagery that consists of multispectral and temporal imagery that captures historic and current state of the Earth, basemaps for reference or context, historical maps which represent the changing physical, political and cultural aspects of the world and Demographics/Lifestyle data for the U.S. and 120 other countries that reveal insights about population and behavior. There are also many other types of datasets in the Living Atlas such as landscape, oceans, urban systems, transportation and Story Maps.

An Organizational account custom portal allows you to introduce your organization (your school, a specific project, or your school district) in a graphic way. The home page serves as a starting point for your members. There are also powerful management capabilities that allow an administrator to control the power of individual users and also limit the amount of data usage that users are allotted.

To request a free ArcGIS Online Organization account go to: http://www.esri.com/connected