Power of Data Teacher Guide

Emily Evans

Mark Manone

Anita Palmer

Lori Rubino-Hare

James C. Sample

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POD Research Team: Nena Bloom, Brooke Whitworth, Megan Walker, Kayla Arendt, and Tia Raught

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INTRODUCTION TO POWER OF DATA

Visit http://www.pod-stem.org/teachers-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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.

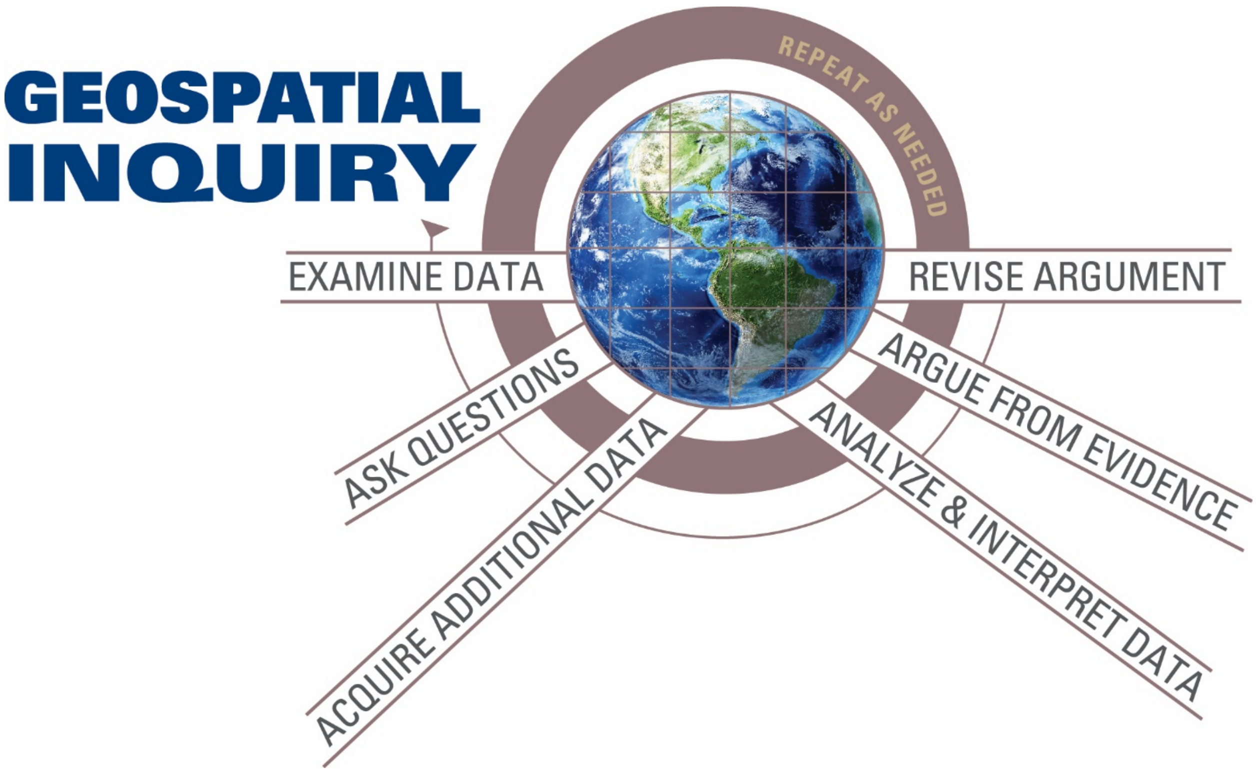
GOALS FOR TEACHERS IN POD TEACHER WORKSHOPS

- 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?

We define 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 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

Geospatial Inquiry includes multiple phases, but it is a continual process and does not necessarily begin or end at any one point. Sometimes, a Geospatial Inquiry starts with a digital map that includes some points, lines and polygons, or "layers". These layers are tied to a great deal of data, facts and statistics. Because they are tied to locations on Earth, these data can be displayed in a geographic information system (GIS), like ArcGIS online.

For example, perhaps we open a map that displays data from the Center for Disease Control. We see that 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 we are in an online environment, we can zoom, pan, and click around the map to **EXAMINE GEOSPATIAL DATA.** We begin to wonder why the features appear where they do. As we explore further and click on individual features on the map, we realize 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 include data about the total number patients treated within a certain time period, their ages, their symptoms, diagnoses, treatments and mortality rates. We can see this by displaying the attribute table that is associated with the feature. We begin to **ASK QUESTIONS** and look for patterns and relationships in the data. For example, we might wonder if there is a relationship between the occurrences of malaria and proximity to standing water. With a question in mind, we can begin to **ANALYZE AND INTERPRET GEOSPATIAL DATA.** We can filter the data to only display malaria cases. Then we can calculate how many instances of malaria occurred within a certain distance to a body of water. Armed with this information as evidence for our claim about this relationship, we are able to display the data for any intended audience, **ARGUE FROM EVIDENCE**, share our findings with stakeholders, receive feedback and **REVISE** our **ARGUMENT** as new evidence becomes available. At any given point along this geospatial inquiry, more **QUESTIONS** may arise, and we may need to **ANALYZE AND INTERPRET** additional **GEOSPATIAL DATA** in order to make an informed decision or better understand whatever we may be investigating.

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 them to explore relationships between features tied to locations on Earth to better understand their world. Because it 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. 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. Students must be equipped to take advantage of technologies that enhance their human capacities for spatial reasoning, like ArcGIS Online.

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?

A Geospatial Inquiry in an environmental science class can 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.**

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**.

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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) – scroll around, zoom in/out, and return home
- 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 Add a Data Layer

- Add – Search for Layers
- Find: (*enter search term*)
- In: 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 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?
- Click Done Adding Layers
- If necessary, 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 #3: Create Map Note Layer

- Click on Add button
- Choose Add Map Notes
- Enter an appropriate name for the Map Note but use the standard template for now
- Choose the tool that fits your need (Points, Text, Line, or Area)
- Click on map
- Enter a title and description
- (*Optional*) Add an image link to "Image Link URL"
- Click Close
- When done – Click the Edit button
- In the Contents pane – Hover over the layer name and click on the " … ") – choose "Save Layer"
- In the Contents pane – Hover over the layer name and click on the "…" – choose "Show Item Details". Click on the "Share" button and then click on "Power of Data"

Task #4: Analyze Areas of Concentration (Density)

- Click on the Analysis Button (next to Basemap)
- 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 is to your Org account
- Click on Show credits to review consumption
- Click the RUN ANALYSIS button

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

In the table:

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

Other table options:

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

1. Click on Options - Filter
2. Set Filter Criteria (e.g. Magnitude is greater than 7.9)

Select features from a table:

1. Select multiple rows in table by depressing shift key and clicking
2. Click on Options – Show Selected Records

Change Styles (Symbology):
Copy layer and map different ways (click on "…" and Copy)

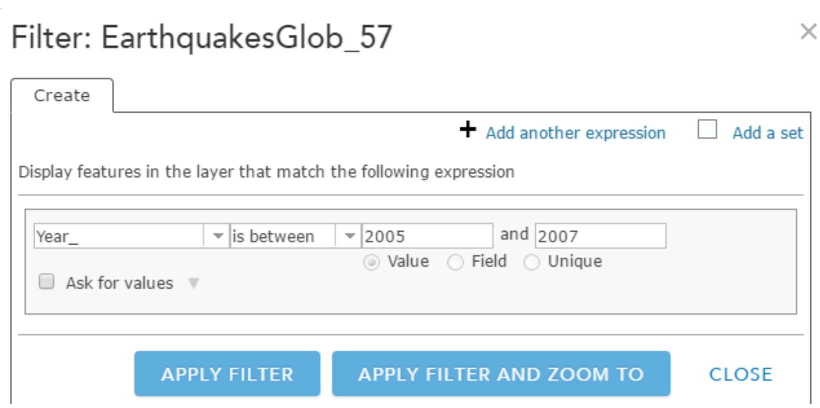
1. Thematic mapping by depth (color)
    a. Hover over the Data layer
    b. Click on Change Style
    c. Choose an attribute to show – (e.g. Depth_km)
    d. Click on Counts and Amounts (Color) Options button
    e. Choose Classify Data
    f. Change classes to 5
    g. Click OK and Done

2. Thematic mapping by magnitude (size)
    a. Hover over Data layer
    b. Click on Change Style
    c. Choose an attribute to show – (e.g. Magnitude)
    d. Click on Counts and Amounts (Size) Options button
    e. Choose Classify Data
    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
    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

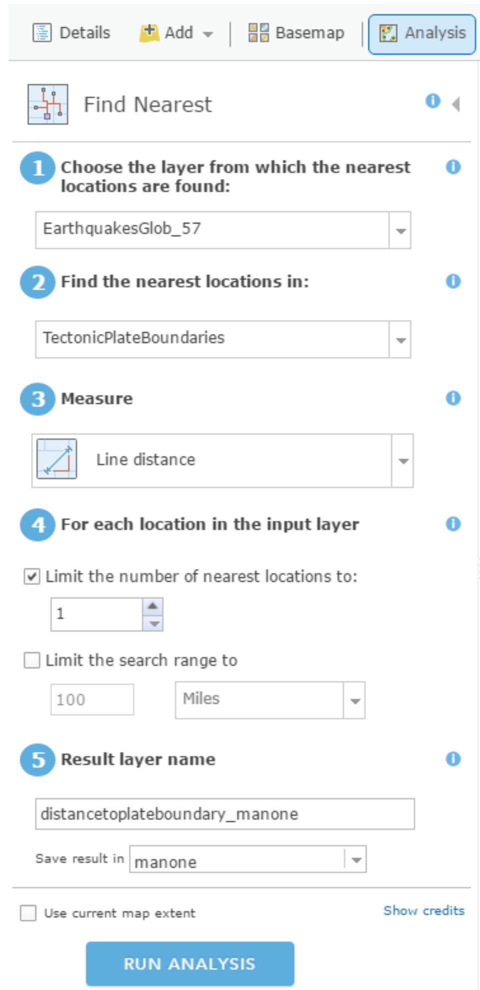
We are going to determine the average distance of earthquakes from plate boundaries for a given time period. To do this we are going to use the Find Nearest tool in the Analysis toolset. This tool can only work with up to 1000 features (points, lines, polygons) and we have over 2000 earthquakes in the 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
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

Close table

Task #7 Creating 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 from the list below you wish to show on this slide
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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PARTICIPANT GRAPHIC AGENDA

Session 1	Intro to POD	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-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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1 About 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. This 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.

Throughout the Geospatial Inquiry, we will assess 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 will serve as an example for the assessment of risk of other natural hazards.

DISCLAIMER: The activities in this example Geospatial Inquiry are not intended for a K-12 audience. 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.

1 GEOSPATIAL INQUIRY PART A AND B

SUMMARY

In Session 1A, work together to answer questions about the relationship between natural hazards, disasters, and risk. Participants first explore the ArcGIS Online interface independently and then are guided through the steps of the geospatial analysis framework as through a focus on one type of natural hazard, earthquakes. Participants will Examine Data on where earthquakes occur and analyze the relationship between earthquake factors (such as depth and magnitude) and areas of concentration for earthquake events.

GOALS (BY THE END OF 1B)

- 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

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?

QUICK WRITE

Explain what the following terms mean to you:

- Natural Hazard
- Disaster
- Risk

TERMINOLOGY AND REPRESENTATION

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

Compare with Handout “Terminology and Representation”

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 #3 Add a Map Notes Layer** for guidance.

Did You Know?

Car navigation systems are often misnamed as GPS. GPS is an abbreviation for Global Positioning Systems, which only provide your location on Earth using satellites. The navigation system in your car that includes maps is actually a GIS!

Work with a partner. 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*

SEARCH FOR AND EXPLORE DATA RELATED TO EARTHQUAKES

Work with a partner. See **Task #2 Add a Data Layer** for guidance.

EXAMINE THE DATA LAYER

Work with a partner to examine the assigned data layer. What patterns do you notice?

ANALYZE AREAS OF CONCENTRATION

Work with a partner. Analyze the assigned data layer for areas of concentration. Refer to ArcGIS Online Task Cards, Task #4 Analyze Areas of Concentration (Density) for guidance.

What questions does this raise?

ACQUIRE & ANALYZE ADDITIONAL DATA

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

EXAMINE the way the data is represented/symbolized.

- What do the arrows mean?

- What does the size of the arrows mean?

EXAMINE patterns in the data.

- Is the relative motion **more** or **less** in certain areas and/or at the margin of particular plates?

- **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?

ARGUE FROM EVIDENCE

Possible Factors/Characteristics

- 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 include factors (such as weather and time of year) that are tied to common misconceptions about earthquakes.

Possible Claims

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___________

MORE INFORMATION on ARGUMENT FROM EVIDENCE:

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

SUMMARY TABLE

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

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.

Eliciting student ideas discussions (EXAMINE DATA and ASK QUESTIONS); Consolidation discussions/connecting activities with big scientific ideas (ARGUE FROM EVIDENCE); Data discussions/making sense of data (ANALYZE AND INTERPRET); Explanation discussions/pressing students for evidence-based explanations or arguments (ARGUE FROM EVIDENCE, REVISE)

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 when "kids decide how much and when to talk—the students end up being in charge, not the teachers ... lead[ing] to diminished learning."

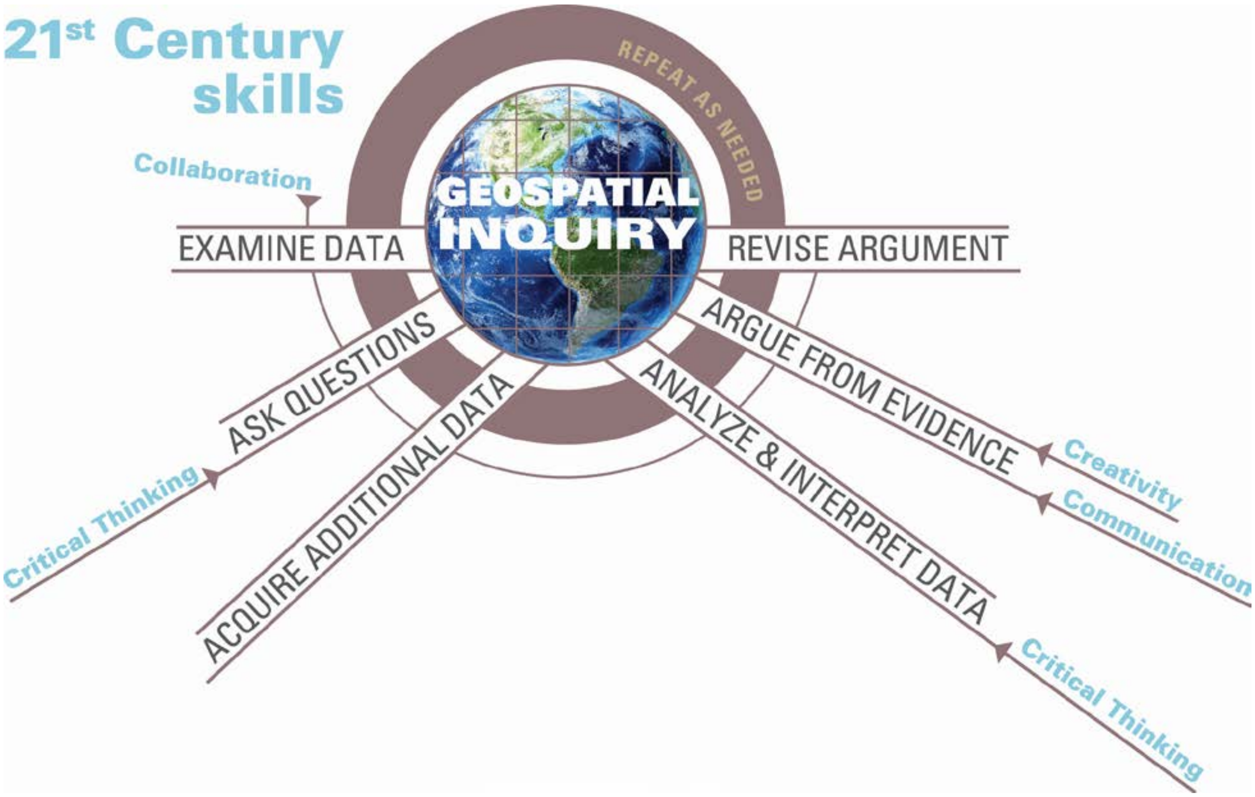
. . . Like with most things, both student-led learning and group projects have benefits despite the negative opinions.

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, consider using this annotation strategy. Be prepared to share what you annotated and why.

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

Metacognition

1. Awareness of one's own thinking and learning processes
2. "Thinking about thinking"
3. Higher-order thinking that enables understanding, analysis, and control of one's cognitive processes, especially when engaged in learning.
   http://www.dictionary.com/browse/metacognition

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?

Beyond the steps of Geospatial Inquiry, other important practices from my discipline in which I engaged include:

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.

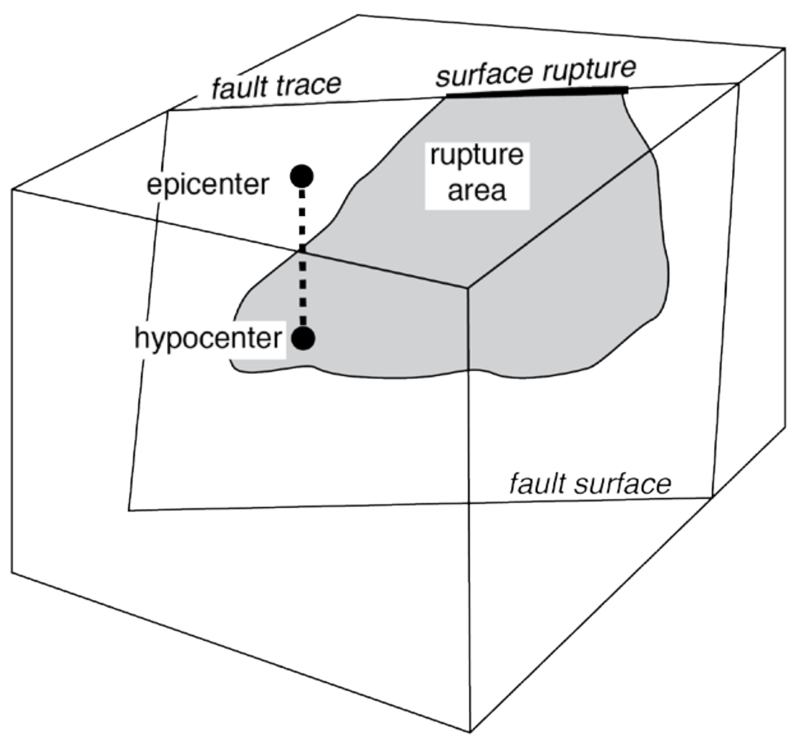


Figure 1. Relationship among fault surface, hypocenter (a.k.a focus), and epicenter. The hypocenter is on the fault surface, the epicenter is on the ground surface directly above the hypocenter. Fault rupture begins at the hypocenter and then propagates in a matter of seconds along the rupture area shown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

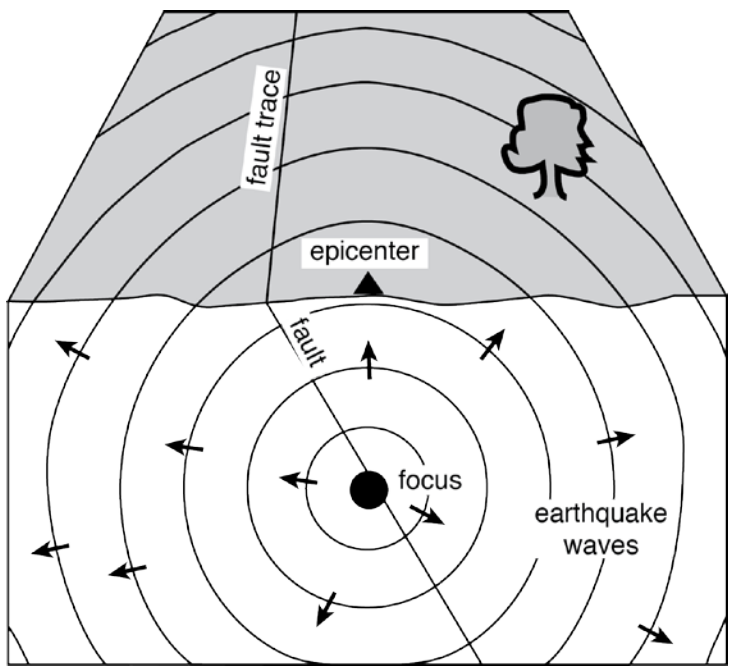


Figure 2. Earthquake waves propagate outward from the earthquake focus in three dimensions at speeds of several thousand kilometers per second. The epicenter is the first point on the ground surface that experiences shaking.

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.

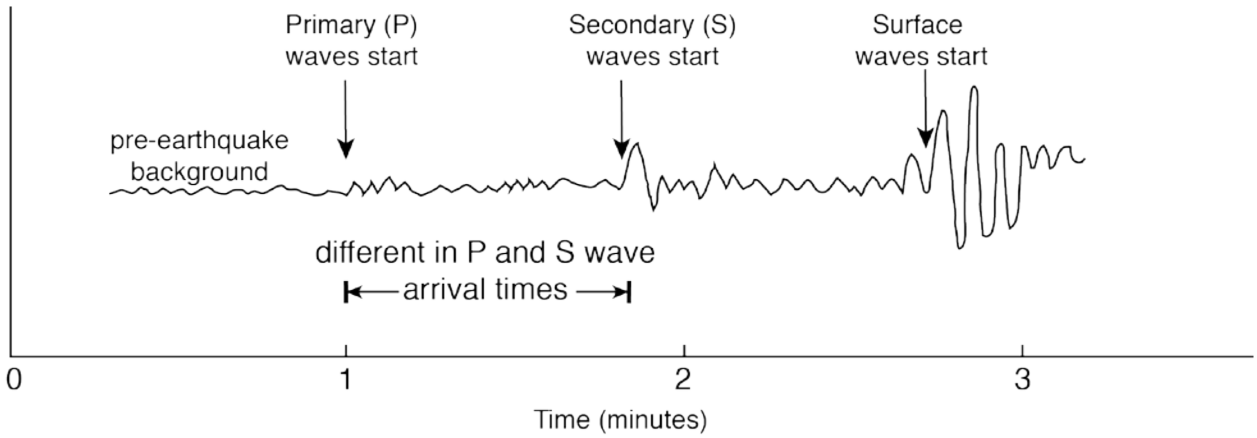


Figure 3. Schematic seismogram showing relationship among P-, S- and surface waves. S-waves travel more slowly than P-waves through Earth. Thus, the difference in arrival times of P-waves and S-waves can be used to calculate the distance from the seismograph to the earthquake epicenter. The greatest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

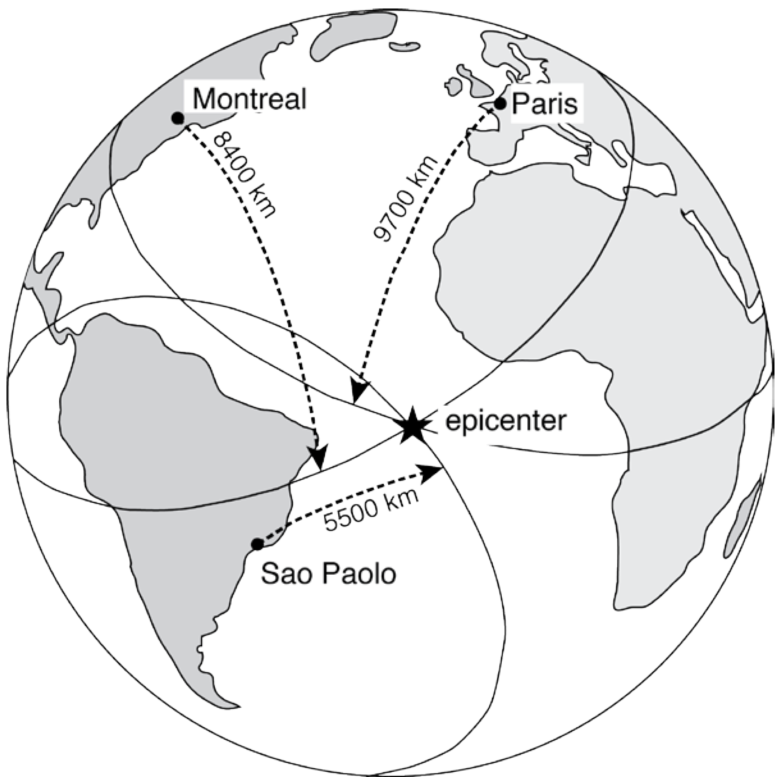


Figure 4. Method of locating an earthquake epicenter using three seismograph stations at Paris, Montreal, and Sao Paolo. The difference in arrival times of P-waves and S-waves (see Fig. 3) can be used to calculate the distance between the epicenter and each station (here 9700 km, 8400 km, and 5500 km). 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).

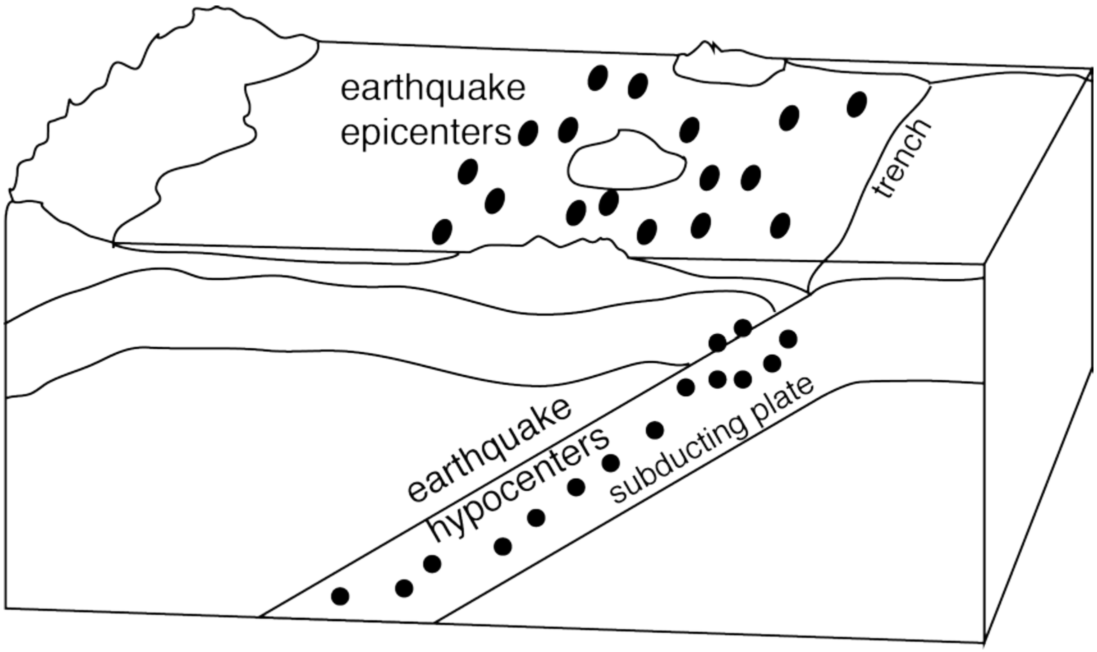


Figure 5. Earthquake hypocenters (black circles) and epicenters (black ovals) in a typical convergent plate boundary. Most earthquakes occur within the subduction oceanic plate. Depths can vary from a few kilometers to 700 km. The pattern of earthquakes at this kind of boundary is one where most epicenters 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.

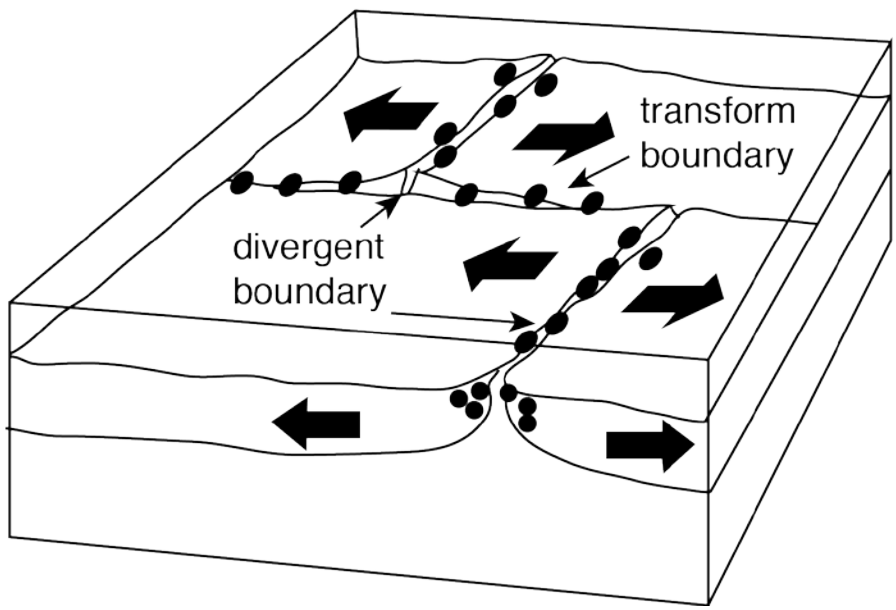


Figure 6. Earthquakes in a typical divergent and oceanic transform boundary. Hypocenters are located in the plates and are generally shallow, less than 15 km depth. In map view the epicenters occur very near the plate boundaries. These margins are most commonly deep in the ocean away from land.

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.

In tasks 2 through 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 created map notes to collect your findings and finally analyzed areas of earthquake concentration by creating a density map using the analysis tools (without being logged into the POD organization account, you would have been unable to use the analysis tools).

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/ > Esri Resources for ArcGIS Online.

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
- Read Geospatial Technology Session at a Glance – Session 2

GEOSPATIAL TECHNOLOGY SKILLS SESSION 2 AT A GLANCE

In session two, you will:

Explore and organize data using the data table

1. Sort by column – ascending or descending
2. Filter by One Variable (e.g. Earthquake Magnitude)
3. Select features from a table

Symbolize and Thematically Map Data

1. Change Styles
    a. Thematic mapping by depth (color)
    b. Thematic mapping by magnitude (size)

Apply Filter button to reduce data size

Analyze data by running the Analysis tool

1. Select Use Proximity
2. Select Find Nearest
3. View Statistics in Table
    a. View the Average

Create and run a Presentation

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SESSION 2 POD TEACHER GUIDE

SESSION 2 AT A GLANCE

Designing a Geospatial Inquiry	Geospatial Inquiry	Career Spotlight	Metacognition & Homework

Visit http://www.pod-stem.org/teachers-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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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. The Geospatial Inquiry Template is introduced. You will choose the big ideas/concepts and possible guiding questions that will guide the Geospatial Inquiry.

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 A GEOSPATIAL INQUIRY LESSON

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

Generate at least one concept from your standards that could be enhanced with Geospatial Inquiry. Choose at least one type of geospatial analysis from the framework above. Provide examples of claims students might investigate.

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.*

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)*

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

Big idea/Concept/Standard:

(*e.g. Natural hazards become disastrous when they occur near densely populated areas or critical infrastructure; Ecosystems are dynamic and fluctuate depending on changes to the environment and in populations of various species).*

Types of geospatial analyses involved:

Guiding questions or claims students could investigate:

Share your idea with your small group. Record each concept your group has identified on chart paper.

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?

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)

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)?

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?

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 how well 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?

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?

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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?

REFINE YOUR CLAIM

Work with your partner to refine your claim (from Session 1B).

What is your claim?

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

What is your evidence?

- 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 reasoning 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 ____________________.

ACQUIRE AND ANALYZE DATA

Acquire and analyze additional data. Does this data support your claim?

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

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.

> 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.

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?

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2 CAREER SPOTLIGHT

SUMMARY

A main goal of the POD project is to improve student interest, awareness and attitude toward STEM careers. This goal aligns with the purpose of the NSF ITEST grants (which support the POD project). These grants are intended to inspire more individuals to pursue STEM careers. As part of the POD project, we will be asking students about their Geospatial Career awareness and interest. The career spotlight pieces are an opportunity for teachers to engage students in thinking about possible STEM careers that include geospatial technology skills and comparing their own work as a student learner with the work of career professionals in different geospatial technology fields.

This spotlight introduces Rohini Saminathan. After experiencing the 2004 tsunami in South India, she became a Geomatics engineer. She currently works with UNOSAT, the Operational Satellite Applications Programme of UNITAR, the United Nations Institute of Training and Research. She is working toward faster, more efficient, more informed humanitarian action and disaster risk reduction.

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

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?

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 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?

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_0 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/ > Esri Resources for ArcGIS Online.

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

Designing a Geospatial Inquiry	Geospatial Inquiry	Career Spotlight	Metacognition & Homework

OVERVIEW AND GOALS

In this homework, consider what teachers must do to ensure their classroom norms and culture and promote academically productive talk. View videos of teachers 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 done to promote or hinder academically productive talk in the POD Workshop thus far? Provide specific examples.

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

2 GEOSPATIAL TECHNOLOGY SESSION 3 AT A GLANCE

In session three, you will:

Add data layers to the map.

1. Use the search terms provided to find the data layers suggested.
2. Select analysis tools to analyze and interpret the data.
3. Save and share map with the POD-STEM organization.

Create a Story Map

1. Create a Web App - Story Map Journal
2. Apply Title, Tags, and Summary fields
3. Select a Side Panel or Floating Panel style
4. Create custom configuration in three areas
    a. Location of study area on your map
    b. Content (data layers) you wish to display on this "pane"
    c. Popups that will be opened when the map is displayed
5. Add the Side Panel text that you wish to display
    a. Format text
    b. Add any links
    c. Add any video clips

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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-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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3 GEOSPATIAL INQUIRY

SUMMARY

Small groups will be responsible for developing a risk determination for one city/region. Groups will use their previous analysis of earthquake characteristics and factors and ACQUIRE and ANALYZE ADDITIONAL about the human systems impacted by these events. Each of the groups will present their findings to one another through a jigsaw presentation. The jigsaw group will then make an overall determination as to which of the cities is at most risk for experiencing seismic disaster.

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

Work with a partner. **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. You might revisit the chart on **page 1-8.**

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 your table group to Acquire, analyze, and interpret data about the natural system and the (human) vulnerable system for your assigned city. 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	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	
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	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)?

CREATE A STORY MAP

Create a Story Map to present your findings from your Risk Determination for your city.

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

Use the categories from the argumentation categories below to guide your 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?

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3 IMPLICATIONS FOR TEACHING WITH GEOSPATIAL INQUIRY

SUMMARY

First, "jigsaw" interviews from teachers who have implemented Geospatial Inquiry to attempt 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. Then compare patterns to your own situation.

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

What barriers might you face? How will you overcome these barriers?

TRENDS AND NOTES

3 Career Spotlight

SUMMARY

This spotlight is an interview with Jessica Block, 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.

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 reviewing the career spotlight piece, consider:

- How does this individual use the steps of Geospatial Inquiry in their work?

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

__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 field. 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 a fire break out and alert us to hazardous fire conditions before they happen.

I also work on a 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.

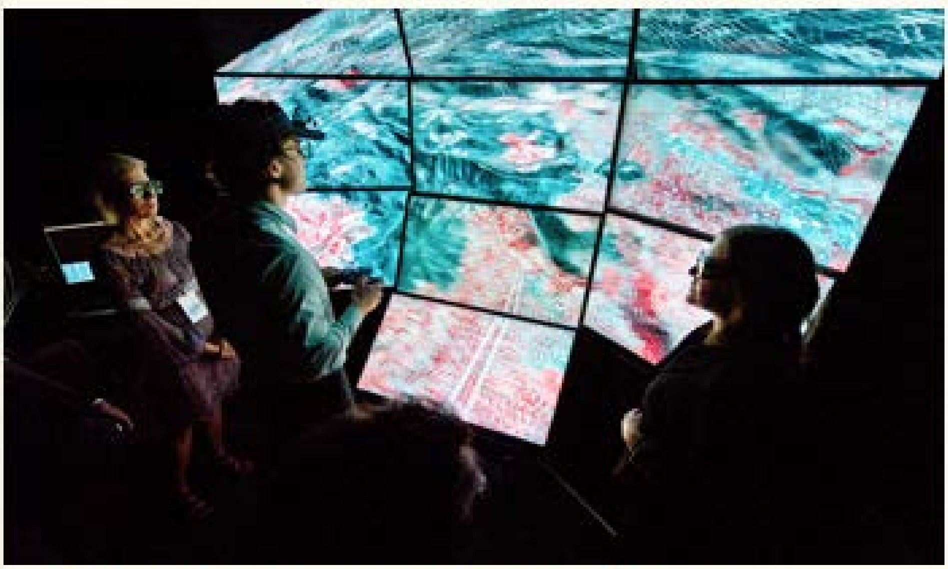
My work varies from day to day. Some days I just get to make maps or collect data from different web sites. For example, I might be working on making a map to figure out where vehicle traffic is in relation to instances of asthma. On other days I'm having meetings with stakeholders or people at my University 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.

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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

- 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 view the videos, consider what the teacher is doing to promote academically productive talk. How might you use these to promote academically productive talk during a geospatial inquiry?

TALK MOVES

https://inquiryproject.terc.edu/prof_dev/library.cfm.html > Talk Strategies (Talk Moves)

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

- Time to think – 7:04

Goal 2: Listen carefully- 4:11

Goal 3: Deepen Reasoning - 5:06

Goal 4: Help students think with others

- Think with others overview – 2:56
- Agree/disagree/why -2:28

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.

RESOURCES FOR SESSION 4

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

The following is a partial list of resources for information about other kinds of disasters that might be useful in planning for sessions 4 and 5.

Some of the vulnerable systems data provided include:

- 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/

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/ > Esri Resources for ArcGIS Online.

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/

3 Geospatial Technology Session 4 at a Glance

In session 4 you will:

- Select data of appropriate scale and from reliable sources
- Choose a geospatial analysis framework that will help you answer a question
- Choose an appropriate deliverable from a list of Esri apps (e.g. ArcGIS Online Presentation, Story Map Journal, Explorer)

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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-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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4 GEOSPATIAL INQUIRY

SUMMARY

You will apply your understanding of the relationship between vulnerable systems and natural hazards from the Geospatial Inquiry on earthquakes to determine the risk of your choice of natural disaster in your local regions. Identify the data and geospatial analyses you need to consider to conduct your own Geospatial Inquiry. Choose the best ArcGIS Online geospatial deliverable for your arguments based on the purpose and intended audience.

GOALS

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

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

PURPOSE:

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

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?

Work with a partner or small group to choose a natural hazard to explore. Develop a plan using the chart below before examining data.

ASK

- What information do you need to make a risk determination for _______________ (hazard) in the ________________ (city/region)?
- What data do you need to acquire?
- How will you analyze and interpret the data?
- Who is your audience?

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

GEOSPATIAL ANALYSIS FRAMEWORK

Consider which of the analyses 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

ACQUIRE & ANALYZE DATA

Consider data categories and corresponding search terms you could use to acquire data in these categories.

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

NOTE: We encourage you to consider how you would go about a data search by completing the chart. However, for the purpose of this inquiry, we have provided a collection of data that includes the appropriate scale.

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.

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

You will read an interview highlighting the conundrum a pair of teachers face when assessing Geospatial Inquiry. You will then 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**, such as instructional rubrics, 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 does this influence your Geospatial Inquiry Lesson?

ACCESS ONLINE, READ, AND NOTE KEY POINTS OF ONE OF THE ARTICLES.

1. Find a partner and decide who is A and who is B.
2. Read and identify key points of your article.
   A. 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

   B. Attributes of Effective Formative Assessment

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

3. Discuss with others who read the same article.
4. Find your original partner. Teach them about what you read and learn about the second article.

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

4 Career Spotlight

SUMMARY

For this spotlight you can choose from a series of videos and/or highlights from an interview with Sean McCartney, the Center lead of the NASA Develop program at Goddard Space Flight Center. The videos and interview highlight spotlight how different career professionals use GIS technology for their work. 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 and why professionals in STEM fields engage in Geospatial Inquiry
- 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 you might introduce geospatial careers to students.

As you read the Career Spotlight (option A) or view the video (option B) consider the following questions:

- 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 Framework in the work of these individuals/organizations?
- How could you use this piece with your students to inspire them to pursue a STEM career?

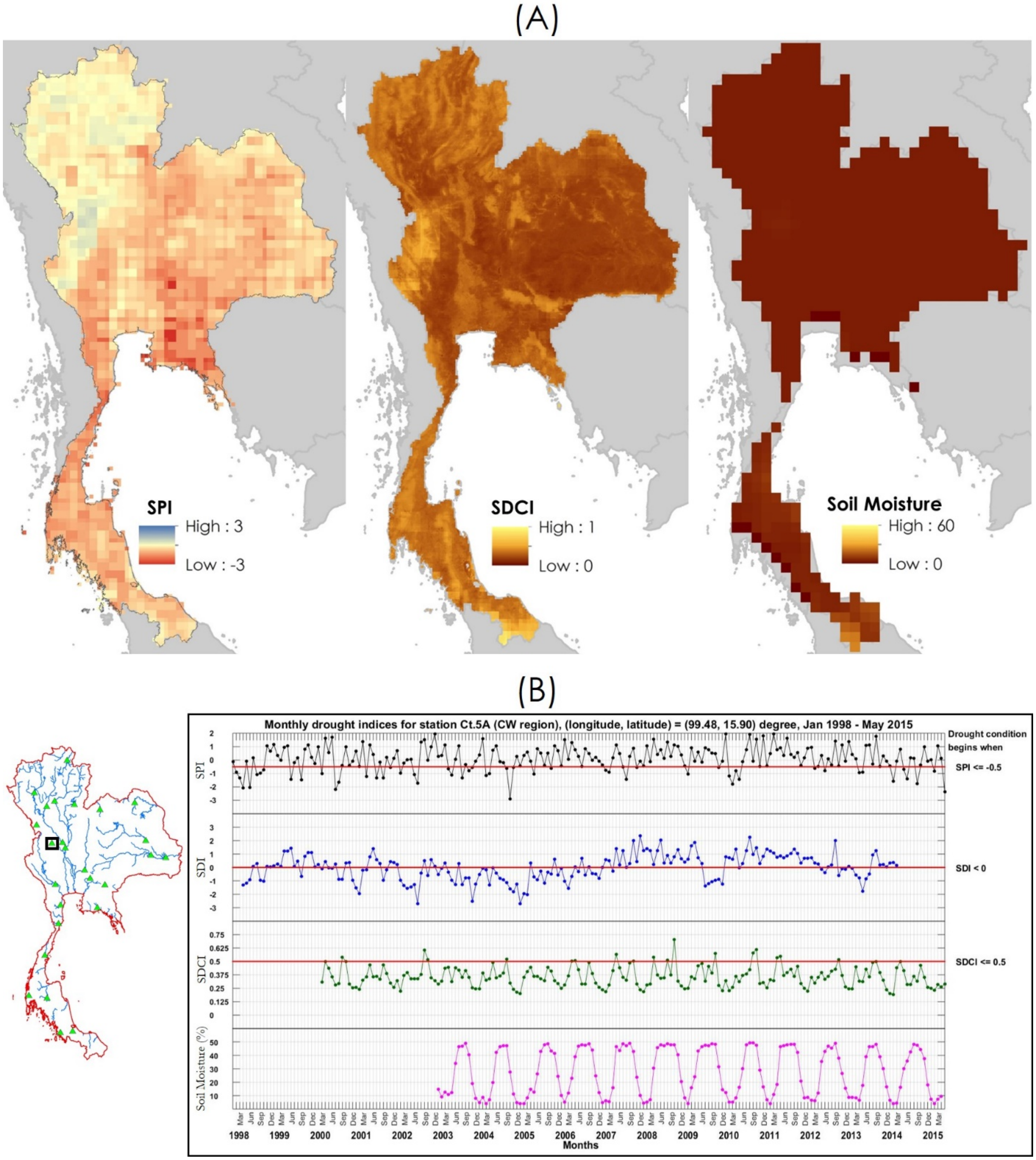
Option A

CAREER SPOTLIGHT

Sean McCartney is the Center lead of the NASA Develop program at Goddard Space Flight Center. We asked Michael to describe a typical workflow for one of this geospatial technology projects.

"When we first start work on a project, we meet with the end user, for example members of an embassy. With the embassy members, we identify exactly what they wanted from us in terms of data and products. Once we knew what we were trying to create and what results we are looking for, then we start gathering data. We have to determine what data is needed and what is appropriate for the project. We also have to identify the tools we will use to acquire and analyze the data. These include the software packages that we need to do statistics and the imaging software. Then we review the research literature to help us wrap our brain around what has already taken place. For our project with Thailand, the whole process (from meeting with the embassy to completing the literature review) took place one year in advance of collecting data. We spent the next 3 weeks completing another intensive literature review. Then we started the data acquisition and analysis process. We went back and forth between looking at the data and comparing the data to our model. This iterative process for analyzing the data took 7 weeks. At the end of the project, we crafted different deliverables such as maps, and science journal papers, and posters. We selected the deliverable for our results that had the best chance of being effective when handed to the agency we were working with on the project. When the project is complete, we back up everything on to external drives with root folders subdirectories. We use very specific systems for storing data so that someone else could access the data and build off this project for a future project."

Example of Sean's Work with the Thailand Embassy Project.



- 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 a Post It note.

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

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

4 DESIGNING A GEOSPATIAL INQUIRY

GOALS

- Consider feasibility of teaching this unit within 6 months of the POD Teacher Workshop with data that is available
- Add technological and communication **scaffolds** to the Geospatial Inquiry lesson
- 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	Agree on common understanding of differences so we can engage as a learning community to answer the question; equity and access to ideas	We need to understand the difference and relationship between these terms before we can determine risk.

Consider need to know and data we need to acquire	Invest in question and start to think about geospatial data as resources	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	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

feedback and revise Lab stations (plate tectonics) and readings	 Explore and better understand reasoning behind seismic events	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.
Examine relationships and 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,	Recognize relationships in spatial data by finding what's nearby and examining most and least Explore and better understand reasoning behind seismic events Argumentation from evidence, communication,	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. 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

receive feedback and revise	evaluation, and reflection	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 finding areas of concentration and finding what's nearby	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 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	CER framework
Academically productive talk	Role cards
Metacognition	Focus questions
Presenting	LDC protocols and rubrics
Providing peer feedback	LDC protocols and rubrics
ArcGIS Online Tasks: adding data, changing styles, using analysis tools, creating presentations	Task cards

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?

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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/ > Esri Resources for ArcGIS Online.

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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-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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5 IMPLICATIONS FOR TEACHING WITH GEOSPATIAL INQUIRY

SUMMARY

You will 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. (5 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.

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5 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 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-lounge/ to access this Teacher Guide online. The password is: imgeospatial2

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