Inquiry-Based Disciplinary Literacy Lesson for Mathematics 2014

Table of Contents

Average Monthly Temperature

Intro / Overview:

This is an inquiry lesson for mathematics that addresses standards that are now required for all students; trigonometric functions and modeling. The lesson integrates skills from the Common Core State Standards for Mathematics and components of the inquiry cycle specific to disciplinary literacy in mathematics. It provides key terminology, websites, and instructional strategies that will provide teachers with an example of how disciplinary literacy functions in a mathematics classroom. For this lesson, students are asked to explore average monthly temperature data for a US city of their choosing. They will then harness the power of technology to investigate how to model this data using a trigonometric equation and keep a journal detailing their findings. Through this investigation they will explore how different parameters influence the graph of cosine and sine. They will also analyze a mathematics text to revise their conjectures, evaluate the writing of their peers, and create a final product based on their experience during the lesson.

Texts:

Temperature Data - http://www.weatherbase.com/weather/state.php3?c=US

Mathematics Text- http://www.classzone.com/eservices/home/pdf/student/LA214EAD.pdf

Mathematics Technology:

Core-Math Tools - http://www.nctm.org/coremathtools

Thinking about text Types

Students need opportunities to work with a variety of text types that represent high quality examples of specific genres within the disciplines. *What types of text will you use in this lesson?*

| Literature	Informational Text	Periodical Article	Informational Website	Blog	Narrative	Poetry	Nonlinguistic Representation	Speech	Other
	✔		✔	✔			✔		✔

COMMON CORE STATE STANDARDS FOR ELA and LITERACY in HISTORY/SOCIAL STUDIES, SCIENCE, and TECHNICAL SUBJECTS

	9-10.1	9-10.2	9-10.3	9-10.4	9-10.5	9-10.6	9-10.7	9-10.8	9-10.9	9-10.10
Reading in Science/Tech:			✔	✔	✔		✔		✔	
Writing:	✔	✔		✔	✔	✔	✔		✔	
Speaking & Listening:	✔			✔	✔					

This lesson is also aligned with the COMMON CORE STATE STANDARDS FOR Mathematics:

The Modeling Standards and High School → Functions → Trigonometric Functions → B.5

Winter 2013-2014 Wind Chill Using Average Daily Wind Speed and Temperature
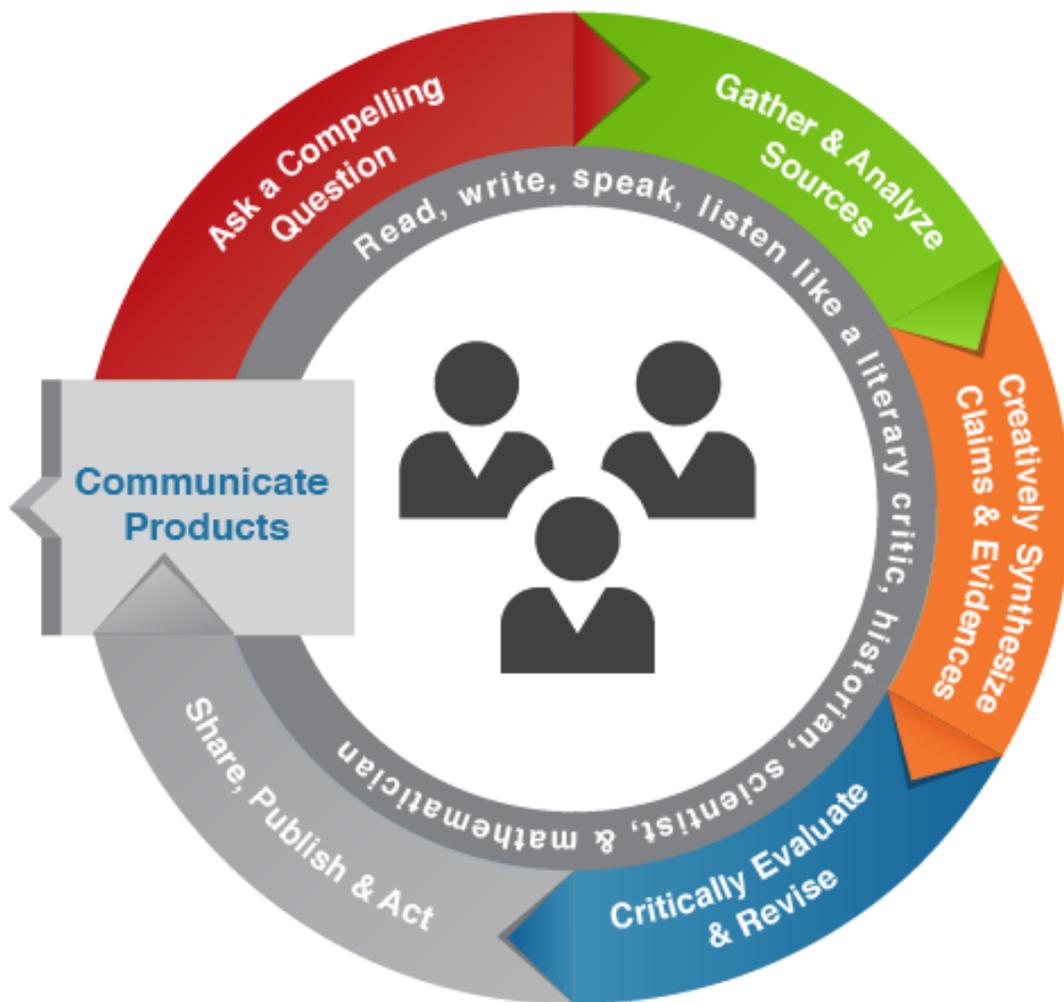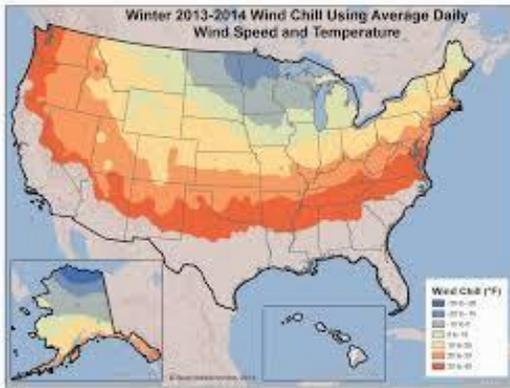
Ask A Compelling Question

Lesson #1 *The Inquiry Process*

Learning Outcomes:

Students will be able to:
- Model weather data using trigonometric functions.
- Explore average monthly temperature for a US city.
- Synthesize across multiple data points to understand how certain parameters of an equation influences its graph.
- Evaluate the parameters for trigonometric functions.
- Use textual evidence to support claims following an investigation.
- Support claims with evidence from an investigation to create a compelling presentation.
- Analyze data to model real-world climate statistics and make conclusions based on comparisons.

Ask a Compelling Question:

For this lesson, the inquiry question is teacher developed. Students will choose which US city they want to study.

- How can the average monthly temperature for a US city be modeled using mathematics?

Domain-Specific Vocabulary:

Average daily temperature, cyclic, periodic, trigonometric function

Directions

Hook:

- Teacher will project the Compelling Question: *How can the average monthly temperature for a US city be modeled using mathematics?*

  o Ask students what is meant by average monthly temperature.

  o Give students 1 minute to predict what the graph of the average monthly temperatures for a city might look like.

  o Discuss and share predictions as a class.

  o Show the class the webpage, http://www.zweigmedia.com/ThirdEdSite/trig/trig1.html, (stopping at the picture of the bicycle) and discuss the weather data for New York's Central Park.

  o Describe what it means for data to be cyclic, or periodic.

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Activity:

- Explain the inquiry method and the question.

    o Through the inquiry process, students will be discovering how to use trigonometric functions (cosine & sine) to model temperature data.

    o Show students the model on page 3. Explain that in different disciplines, we conduct investigations a little bit differently and in this mathematics investigation we will be modeling trig functions.

    o Show students the model on page 5. Explain the links between the inquiry process and what it takes to read, write, and speak like a mathematician.

- Students will create a free online journal at penzu.com to keep an investigation journal and record ideas during the inquiry process.

Closing:

- Students can ask any questions they have about the inquiry process.

When you read, write, speak, and listen like a mathematician:

Ask a Compelling Question	
Gather & Analyze Sources	▪ Read advanced textbooks and real life texts involving symbolic notations, graphic representations, illustrations, etc. ▪ Analyze logic of argument with less attention to authorship. ▪ Understand precise mathematical meaning in terminology & concepts.
Creatively Synthesize Claims & Evidences	▪ Organize tangentially. ▪ Navigate among and interpret sentences, symbolic notations, & graphic representations. ▪ Look for and express regularity in repeated reasoning. ▪ Construct viable arguments using abstract and quantitative reasoning
Critically Evaluate & Revise	▪ Monitor by critically questioning logic and reasoning. ▪ Revise for precision. ▪ Represent response in multiple formats, e.g., equations, diagrams, models, tables, etc.
Share, Publish & Act	

The Inquiry Process for Mathematics

"Considering mathematics as a language implies that students not only must learn the concepts and procedures of mathematics, but must learn to use such ideas to solve non-routine problems and learn to mathematize in a variety of situations"

-- Thomas Romberg

Gather & Analyze Sources

Lesson #2 *Locating Data*

Hook:

Show the monthly average temperature for New York City, http://www.weather.com/weather/wxclimatology/monthly/graph/USNY0996, make sure to show students the multiple representations of the data ("Table Display" and "Graph Display"). Explain that students are going to pick a city of their choosing and find temperature data for that city and then fit a trigonometric function to the data using technology tools.

Activity:

Explicit Instruction

Teacher shows students how to download and open the free Java-based Core-Math Tools program, http://www.nctm.org/coremathtools. Then the teacher instructs students to open the Computer Algebra System (CAS), it is the top application on the left under Algebra and Functions. As the teacher explains how to use the software application, important things to make sure the students understand are:

- Once in the CAS, students need to open a new data window. To do this, click on "File" and then "Data" and then "New Data". This will enable both the CAS and spreadsheet features to be enabled.
- In the "Y=" tab have students enter the following:
  - y=a*cos(b*(x-h))+k
  - It is important they enter it exactly like that
  - Explain that a, b, h, and k are parameters of the equation; they will be manipulated during their investigation.
  - Explain the difference between a variable (the "x") and the parameters.
- The "Settings" tab can change the window of the graph.
- The "Graph" tab will plot a graph of the cosine function and there will be sliders for each parameter. Give the students a couple of minutes to become familiar with the sliders, moving them back and forth and allowing them to see how it changes the graph. To change the range of a parameter, click on the letter of the parameter and enter the new range.
- The "Data" tab is where they will enter data for the city of their choosing. They should label column A "Month" and column B "Average Daily Temperature".
  - For "Month" we need quantitative data, so students should use 1, 2, 3, etc. to represent January, February, March, etc. If it is appropriate you can discuss with students the difference between numerical (quantitative) and categorical (qualitative) data, but it is not imperative for the lesson. Though it is important for students to know they have to use numbers to represent months so that they can graph the data and model it with a function.

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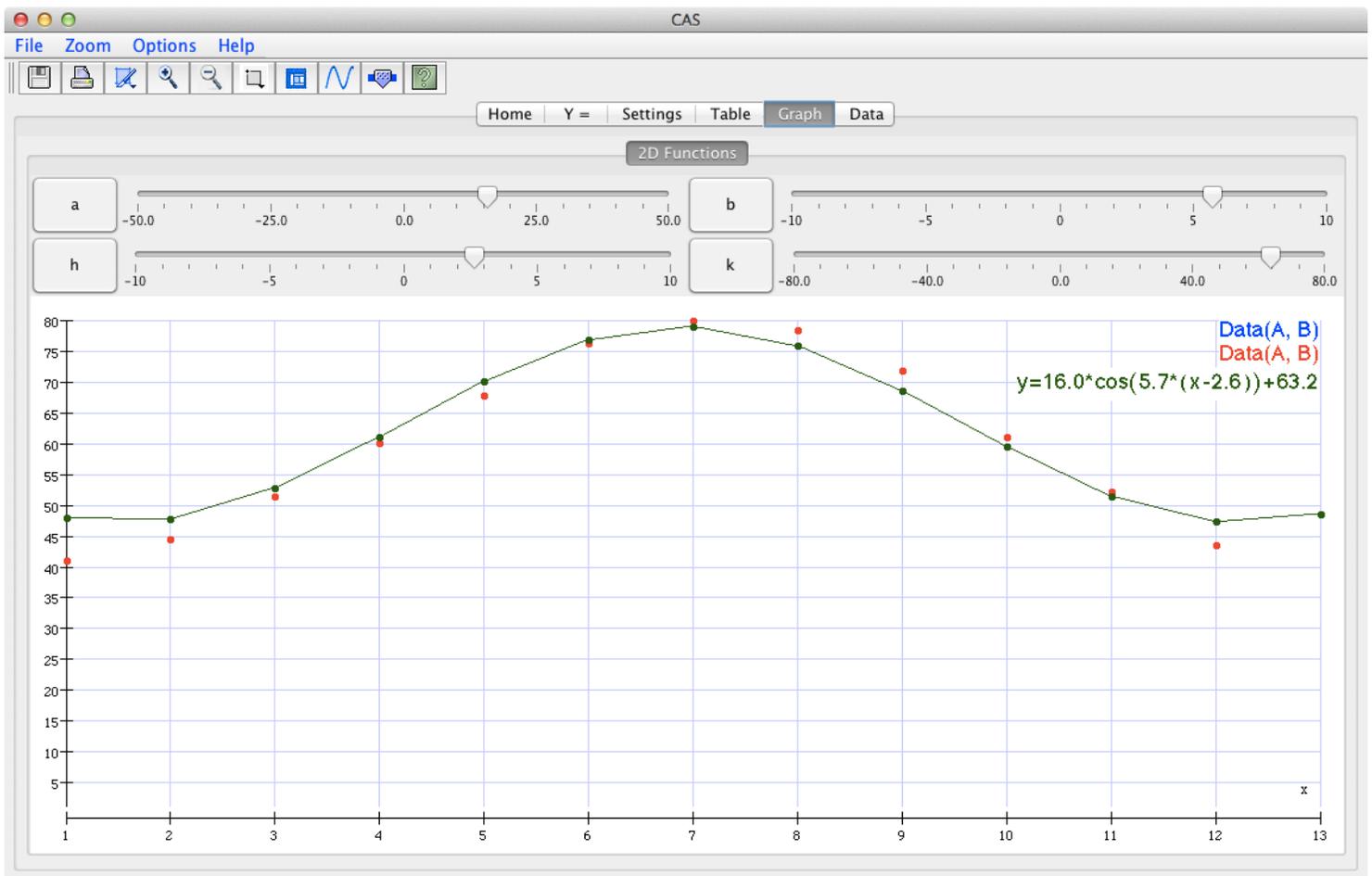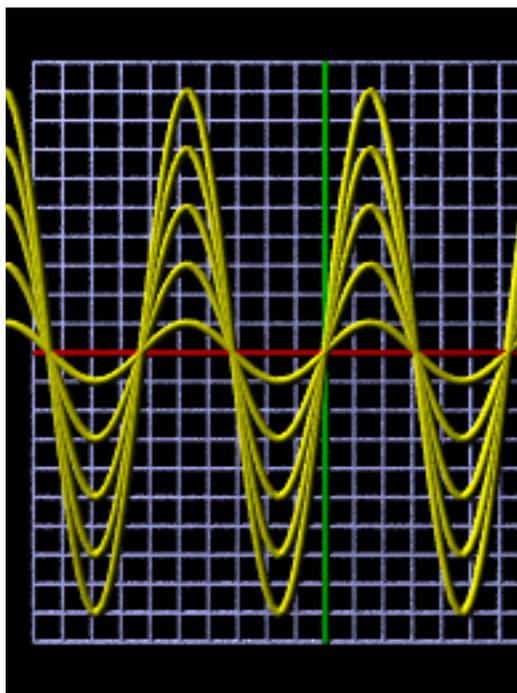
Activity:

Independent Practice

Students will explore average monthly temperature data for a US city of their choosing. Students will find the average monthly temperature online for the city of their choice. They can find their data from doing their own search online, or they may be directed to http://www.weatherbase.com/weather/state.php3?c=US. Once they pick their city and find appropriate data they should enter it into the data tab of their Core-Math Tools. To plot their data they should:

- Click on the "Show Scatterplot" icon
- The default column selections are appropriate for the data so click "OK" when asked to choose columns.

Students should write in their Penzu journal about the city they found, the shape of the graph they are modeling, and any conjectures they have about the cosine function they will model.

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Creatively Synthesize Claims & Evidences

Lesson #3 *Investigation and Conjecturing*

Activity Prompt:

Using the inquiry question to guide your thinking, update your Penzu journal with what you discover about each parameter of the cosine function and the function that modeled the data for the city you chose.

To begin, students should go to the "Graph" tab and manipulate the parameters to model a cosine function to the data they gathered. Then, they should write in their journal according to the stipulations below.

Your journal should address all of the following questions:

- What is the name of the city you chose?
- What function models your temperature data?
- If you were to visit this city in the winter, what type of clothes would you need?
- If you were to visit this city in the summer, what type of clothes would you need?
- How did each of the parameters influence the graph of y=cos(x)?
  - a
  - b
  - h
  - k
- How could you use your data to find each of the parameters? In other words, write an equation for finding each parameter.
- How would your function change if you wanted to model your data with a sine function? In the "Y=" tab, enter y=a*sin(b*(x-h))+k.

As you write remember to:

- Be sure to state your conjectures clearly, it is okay if you revise them later.
- Support your claims with evidence from your investigation.
- Use precise mathematical terminology, including symbols and definitions.
- Use multiple representations as you explain your results: tables, graphs, equations, pictures, etc.

Students will self-evaluate findings from their investigation by reading a mathematics text and comparing their results to the textbook source. Then, they will revise their conjectures. Finally, students will compare their work with their peers' to reach conclusions.

Directions

Students will read a mathematics text about trigonometric equations. One example can be found at: http://www.classzone.com/eservices/home/pdf/student/LA214EAD.pdf, or any standard Pre-Calculus book could be used. Here students will learn the terms: sinusoidal, amplitude, period, horizontal shift, and vertical shift. This technical reading will introduce them to the standard methods for finding the amplitude and period for trigonometric models. Students will learn to use appropriate symbols and terminology when working with trigonometric functions.

Next, students will revise their Penzu journal based on the findings of their reading. They will begin to finalize their argument for the compelling question as they revise their conjectures. If they need more exploration to attach meaning to what they read, they can open a new window in Core-Math Tools and explore how different parameters (when considered in isolation) influence the graph of $y=\cos(x)$. They should be encouraged to explore: $y=A*\cos(x)$, $y=\cos(B*x)$, $y=\cos(x-h)$, $y=\cos(x)+K$

As a next step, students should assess their peers' responses to the compelling question, noting the common inferences and results other students reached. As they critically review, students should consider questions such as these:

- What similarities are there in students' reasoning?
- What disagreements or variations did the students encounter?
- How do their responses compare to the mathematical text?
- Why does their trigonometric function not exactly model the temperature data they collected?

Share, Publish & Act

Lesson #5
Reporting Findings

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Directions

As a culminating activity, after students have revised their hypotheses based on the mathematics text and a review of their peers' work, students should publish their analysis. The publishing process should consist of two activities. First, students should prepare a final draft of a report on their analysis as a response to the compelling question - *How can the average monthly temperature for a US city be modeled using mathematics?* The written response should include an appropriate amount of evidence drawn form the investigation and mathematics text. These final drafts should also reflect the critical evaluation and revision process. The follow criteria can be used to evaluation students writing:

- A rich description of how they used the technology features of Core-Math Tools to model the temperature data.
- Their conclusions about how to find the amplitude and period for their equation.
- Their interpretation about how to use the data to plan their outfits if they vacationed to the city during different seasons.
- Inclusion of evidence to support their claims following the investigation and analysis of the mathematics text.
- Clearly written with limited grammatical errors.
- Proper use of mathematics symbols and definitions.

The second activity is for students to adapt their written work into an alternative format using an emerging technology. This adaptation should reflect multiple representations of their data and how they can use trigonometric equations to model data. Some platforms for publishing include,

- Twitter
- Pinterest
- Facebook
- Prezi

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