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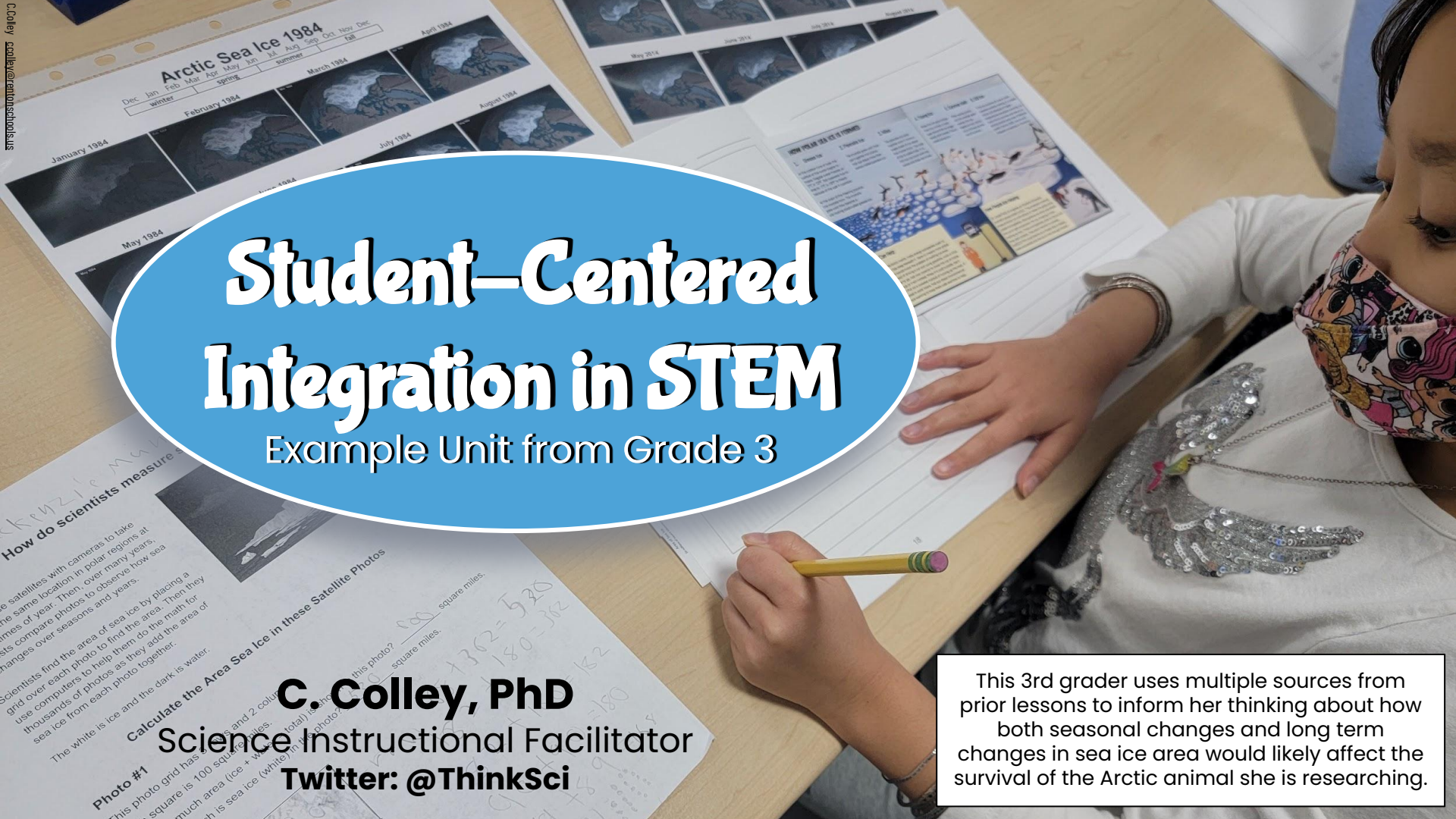
Student–Centered Integration in STEM

Example Unit from Grade 3



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This 3rd grader uses multiple sources from prior lessons to inform her thinking about how both seasonal changes and long term changes in sea ice area would likely affect the survival of the Arctic animal she is researching.

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Chapter 6:
Potentials & Pitfalls of Integrating across Domains

"Children often have **disjointed experiences** of the school subjects throughout the day, perhaps because they have **limited opportunities** to **synthesize their learning across content areas or make connections** among them (Stevens et al., 2005). Integrating science and engineering with the other content areas and domains [...] has the potential for addressing this issue and **enhancing the amount of instructional time spent in science and engineering**." (p. 155)

National Academies of Sciences, Engineering, and Medicine. 2022. *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26215.

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Grade 3 Example Unit

Weather, Climate, & Animal Survival

How do changes in weather and climate affect living things?

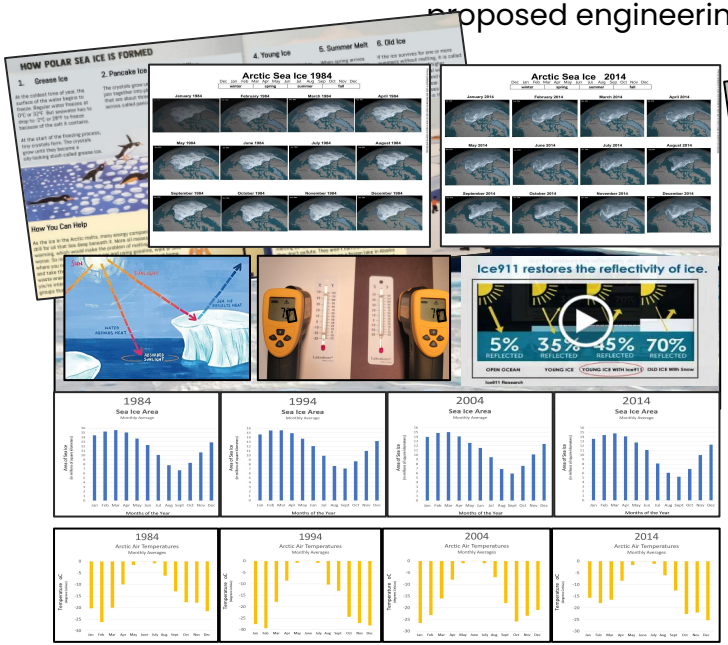
Reading & Writing Lessons

Animal Research Clubs &
Non-Fiction Informational Books

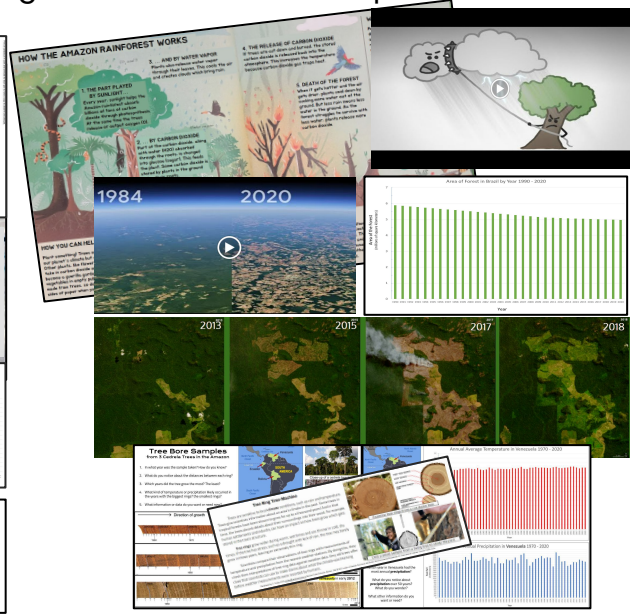
Writing: The Art of Information Writing

Science (& Math) Lessons

Analyze weather data & habitat area and use information from text and video to identify factors that affect habitat preservation or loss & critique proposed engineering solutions to human impacts



The High Arctic
(Sea Ice & Weather)



Equatorial Rainforest
(Deforestation & Weather)

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Grade 3 Example Unit – Student Outcomes

Weather, Climate, & Animal Survival

How do changes in weather and climate affect living things?

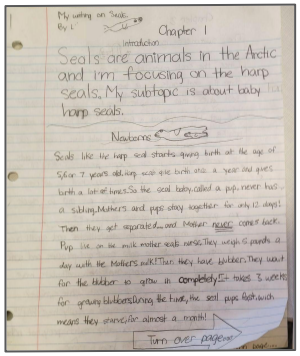
STEM Identity High engagement, positive energy, passion; STEM careers

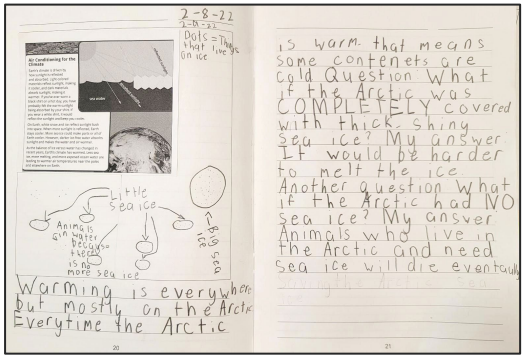
Connections Used knowledge & skills from one area in another

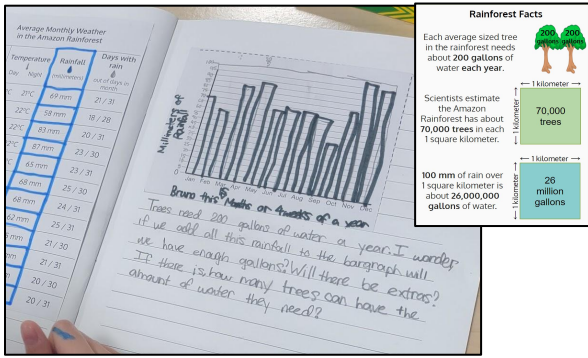
Math/Science Deeper understanding of meaning of graphs (read/create/critique)

ELA/Science Synthesizing meaning across multiple "texts"

Engineering Identified criteria/constraints, analyzed proposed solutions, debated w/evidence about potential impacts







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Grade 3 Example Unit

Weather, Climate, & Animal Survival

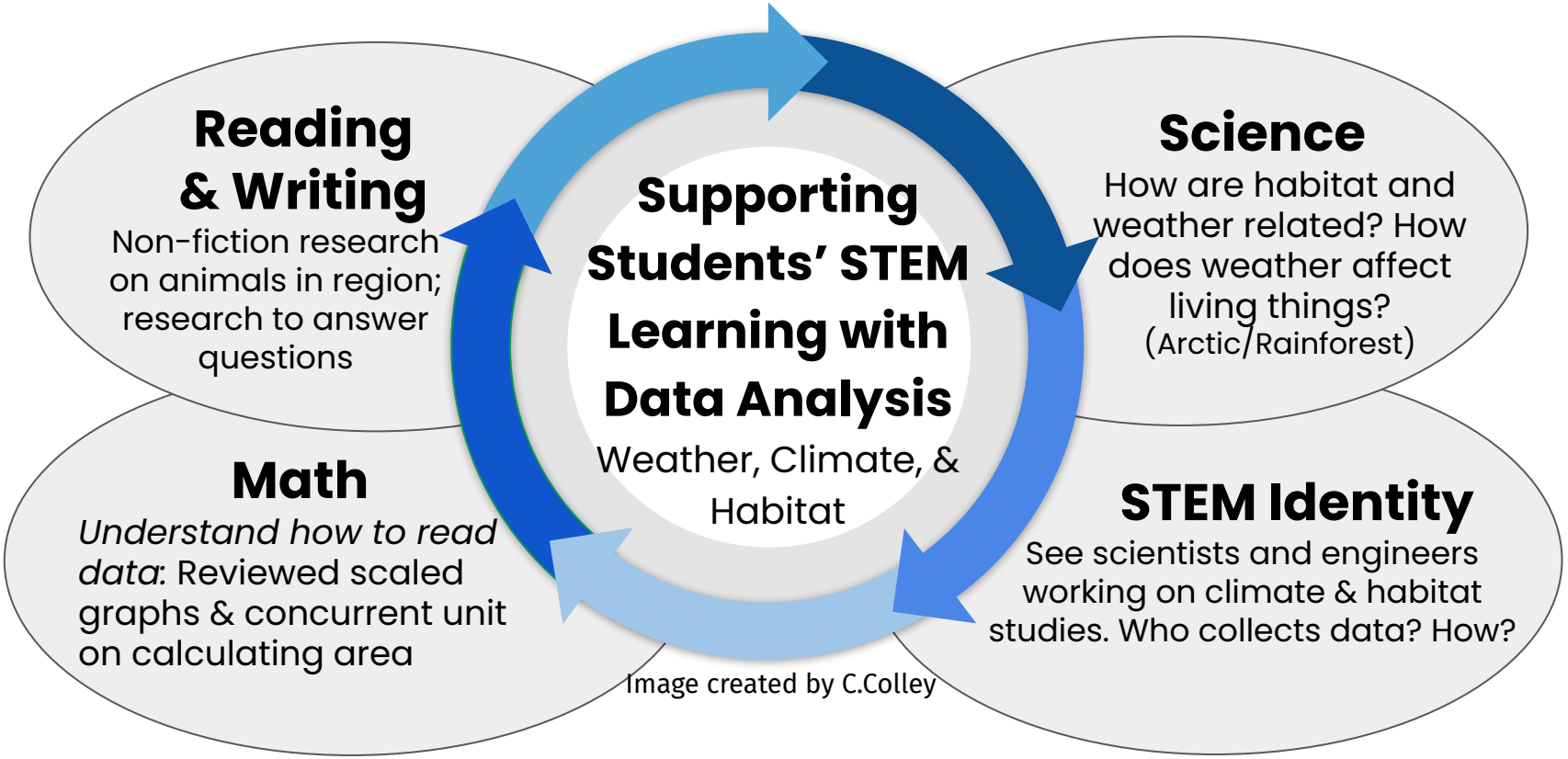

Image created by C.Colley

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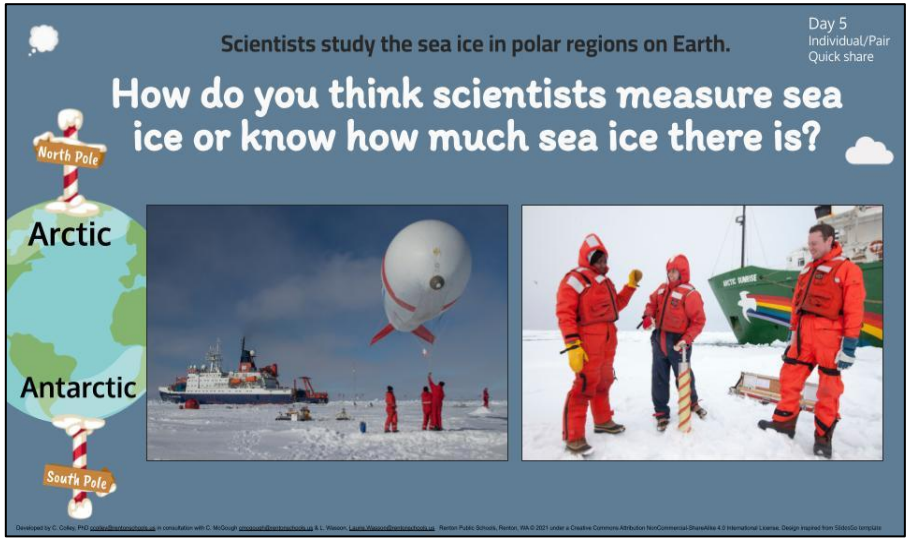
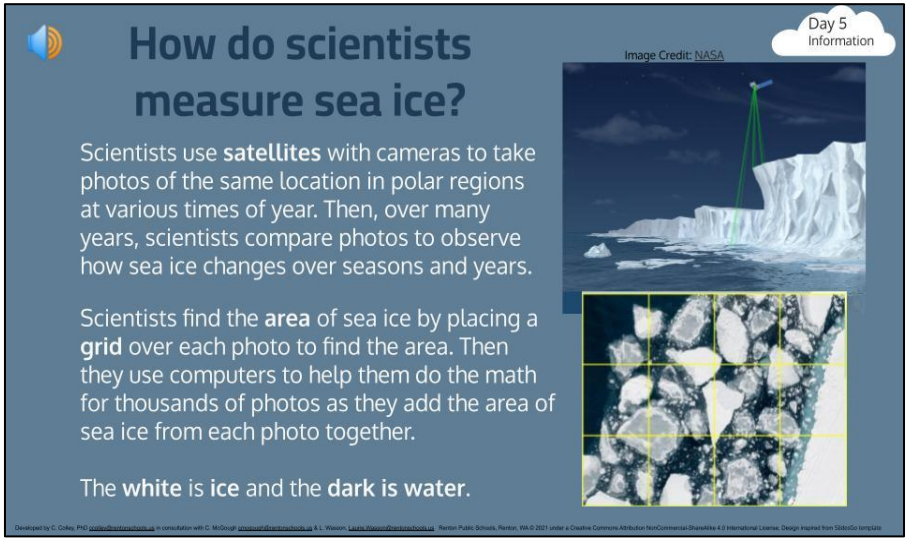
1. STEM Career Connection

How was this data collected?
Highlight STEM careers and work of scientists & engineers + tools they use

Lesson Example from the Arctic region:

- How much Arctic sea ice is there?
- How does the area of Arctic sea ice change over time?





Reading Unit Connection: Animal Research Connection

Students noticed how strong (thick) the ice appeared from gridded photos of sea ice areas and shared conjectures about which squares of the grid of ice would support smaller seals versus larger polar bears.

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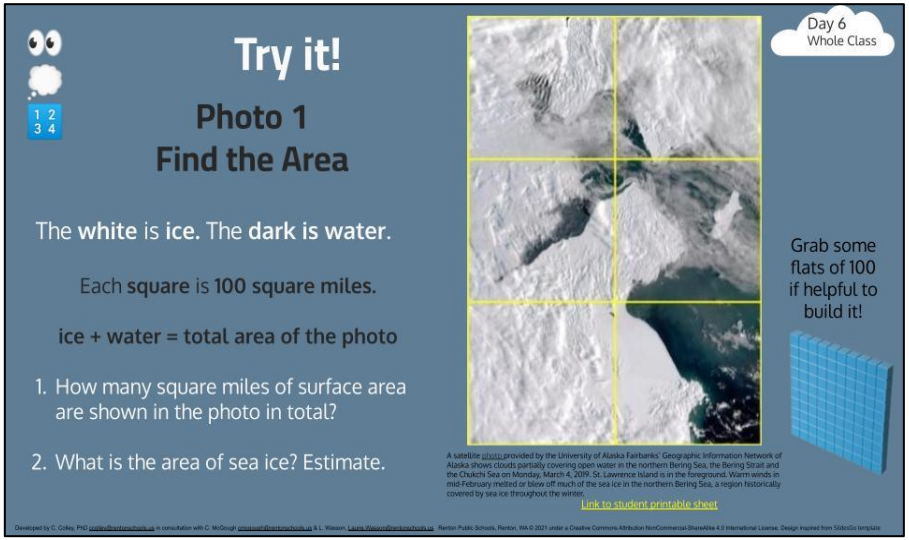
2. Try it! Measure & Collect

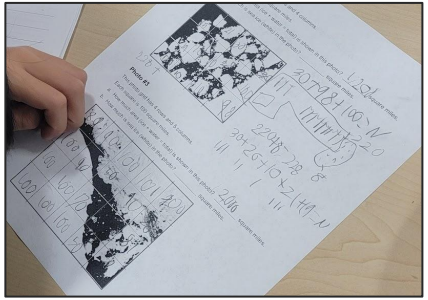
Approximate Data Collection

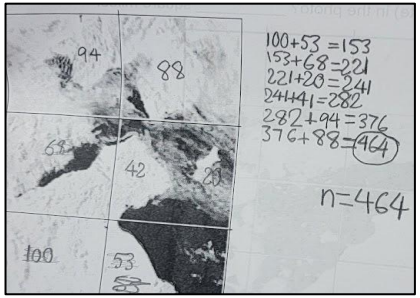
Try technique or tool for data collection
Simulate/approximate measurements or data collection to understand what the numbers mean

Lesson Example from the Arctic region:

- How much Arctic sea ice is there?
- How does the area of Arctic sea ice change over time?







Math Unit: Area & Perimeter
Calculate & estimate area in science context

CCSS.MATH.CONTENT.3.MD.C.5.A *A square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.*
CCSS.MATH.CONTENT.3.MD.C.6 *Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).*
CCSS.MATH.CONTENT.3.NBT.A.2 *Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.*

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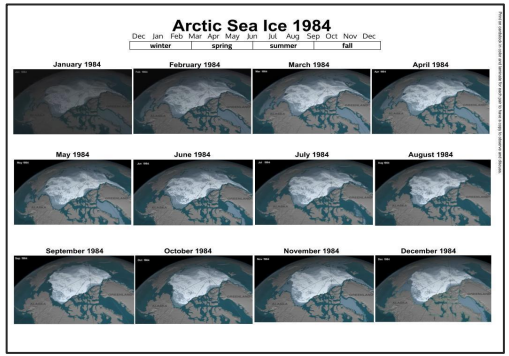
3. Analyze & Interpret Data

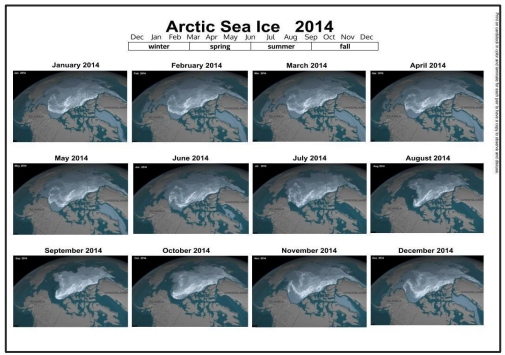
What does the data say?
What does it mean?

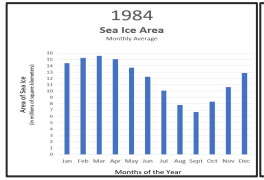
Examine scaled graphs, photos, animations, etc.

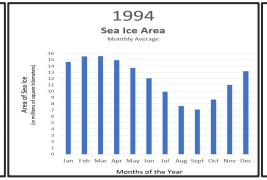
Lesson Example from the Arctic region:

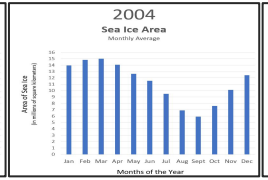
- How much Arctic sea ice is there?
- How does the area of Arctic sea ice change over time?

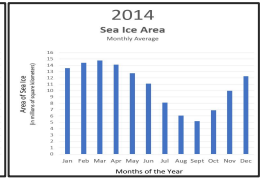


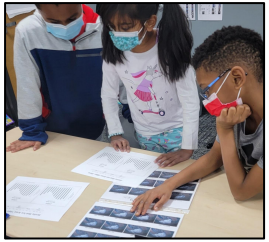


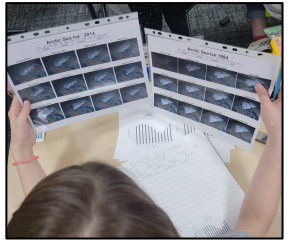


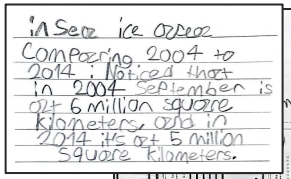


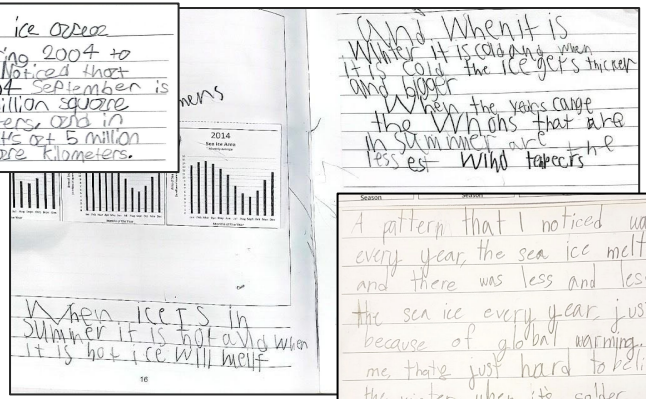


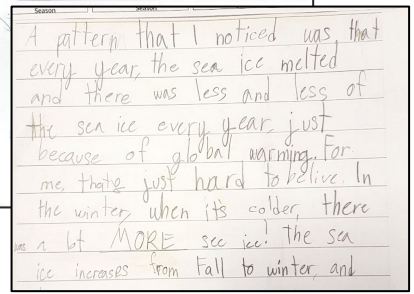












Math Review: Scaled bar graphs

CCSS.MATH.CONTENT.3.MD.B.3 *- Draw a scaled picture graph or bar graph to represent a data set*
CCSS.MATH.CONTENT.3.NBT.A.2 *Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.*

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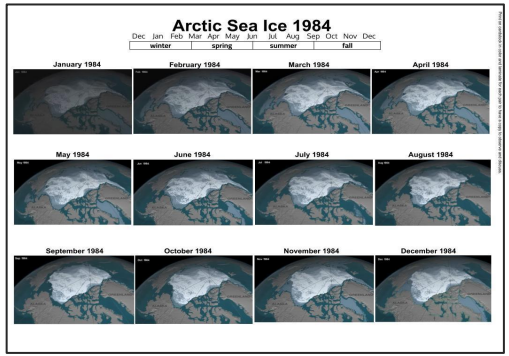
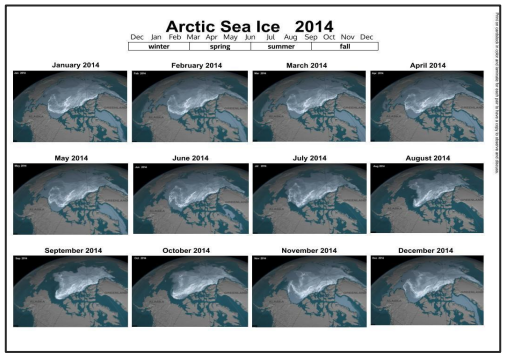
4. Ask Questions

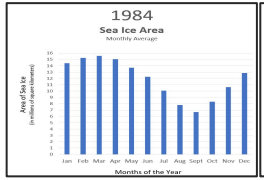
Decide who/when to help answer questions or address requests for data

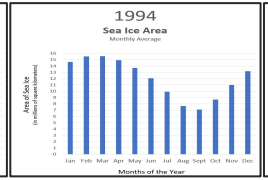
Lesson Example from the Arctic region:

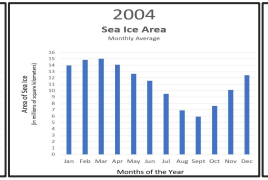
- How much Arctic sea ice is there?
- How does the area of Arctic sea ice change over time?

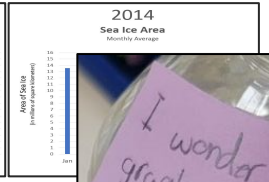


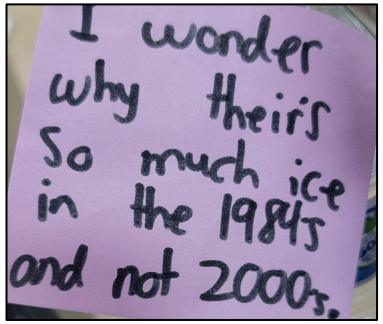


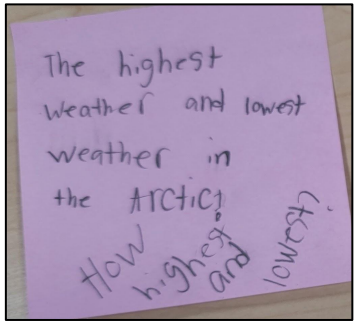


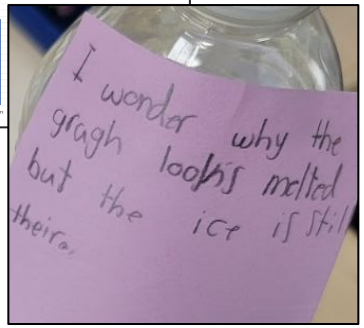


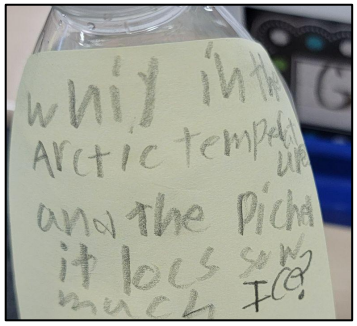


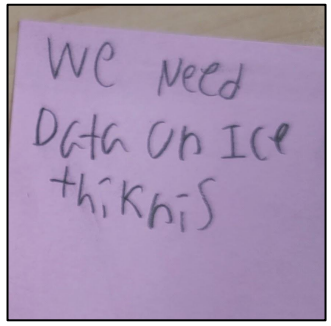












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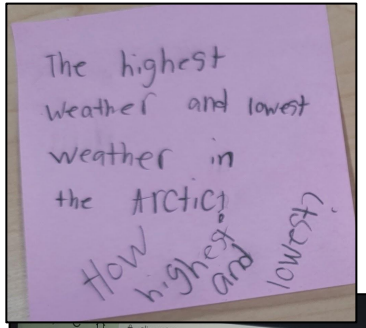
5. Research & Reflect

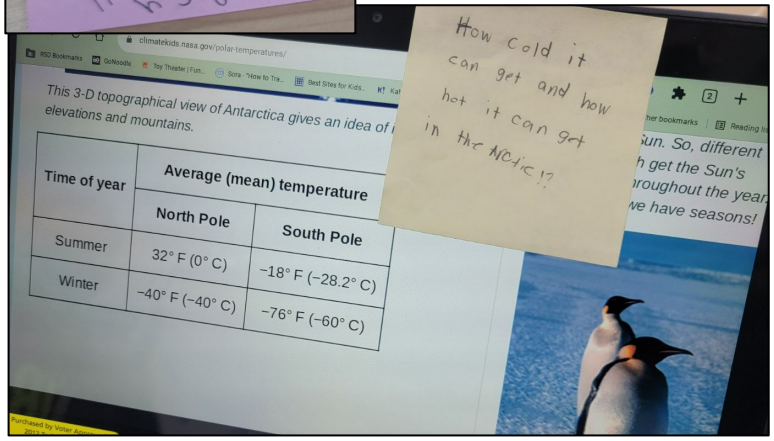
Research questions or analyze requested data. *What wonderings or hypotheses do you have now?*

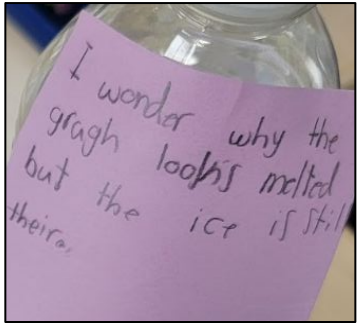
Lesson Example from the Arctic region:

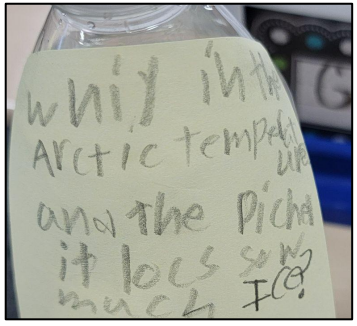
- How much Arctic sea ice is there?
- How does the area of Arctic sea ice change over time?

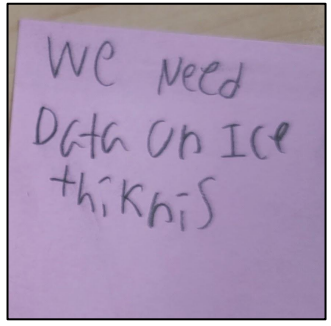


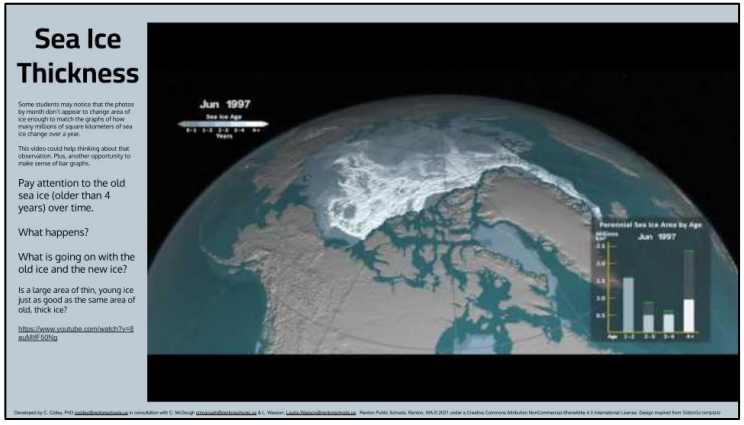
Student researched to answer temperature question and asked another question.











As a class, we watched thickness bar graph of ages of ice layers, which led us to connecting back to ideas about **temperature and seasons** ("colder in winter, warmer in summer")...

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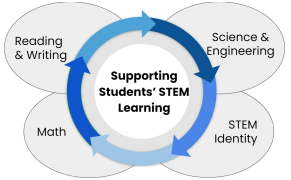
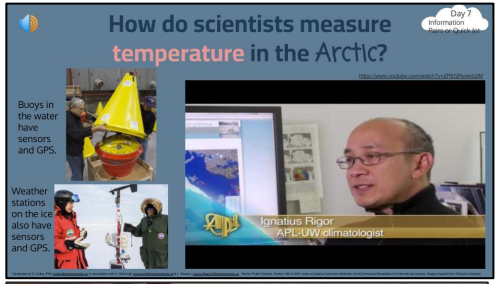
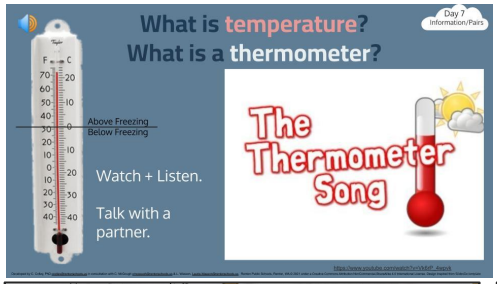


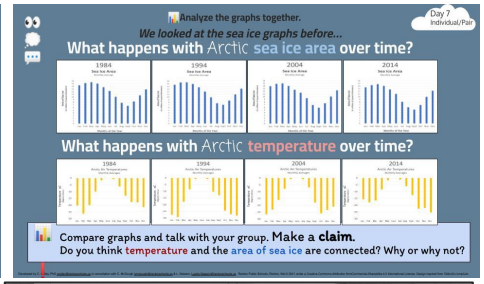
Next data analysis cycle: Arctic Temperature Data

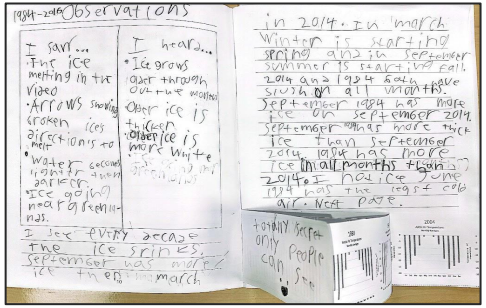
Lesson Example from the Arctic region:

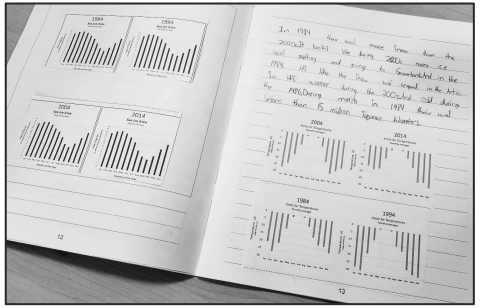
- If sea ice is going away, is it melting? We know water has to be cold enough to freeze to make ice and if it's too warm it melts. → So, what is the temperature like in the Arctic?
- How does the temperature data relate to the sea ice data?











Reading Unit Connection: Animal Research Connection

Students used what they had learned about the traits and physical features of their animals to think about how they stay warm or comfortable in such cold temperatures.

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Preparing to integrate across content areas in service of students' STEM learning

Tip 1: Align units to support coherence and connections for sensemaking

Tip 2: Revise materials in service of STEM goal(s)

Tip 3: Prepare to be responsive

Tip 4: Build identity, awareness, & interest

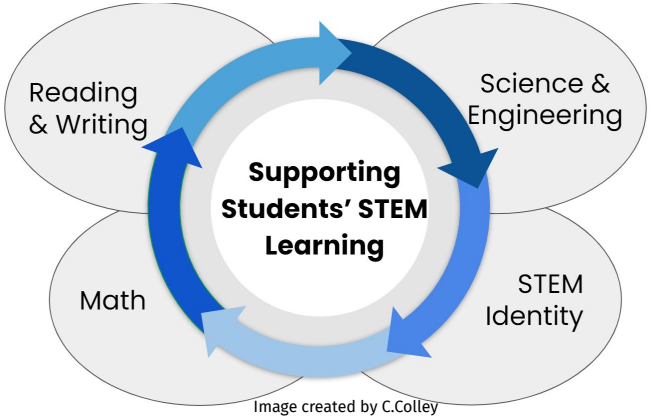

Image created by C.Colley

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Extra Slides 14-16

Useful tools, Collages at-a-glance of each featured region (Arctic / Rainforest)

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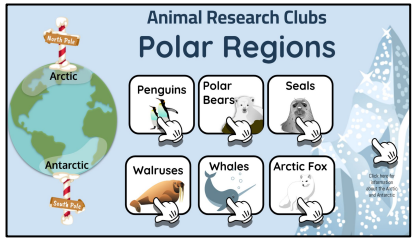
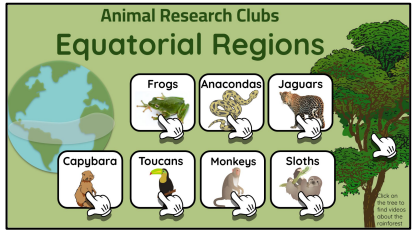
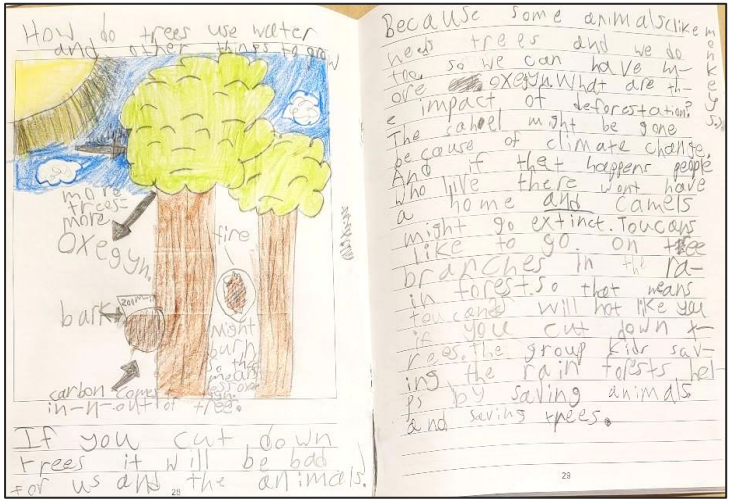
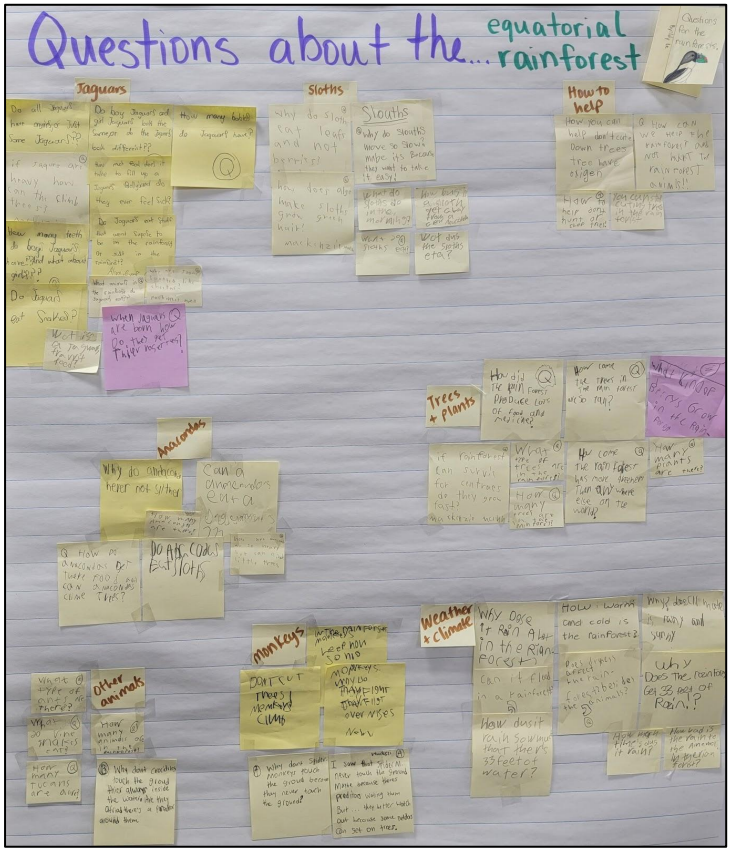
Useful Tools

- Driving Question Board (ELA & Science)
- Science Notebooks (thinking place for me)
- Research Folders (draft/publish for others)
- Interactive Digital Library (Google Classroom) & Book Boxes



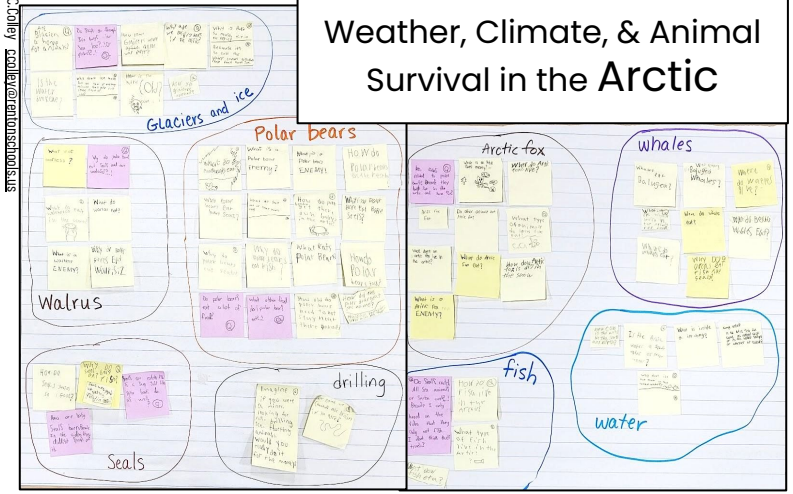


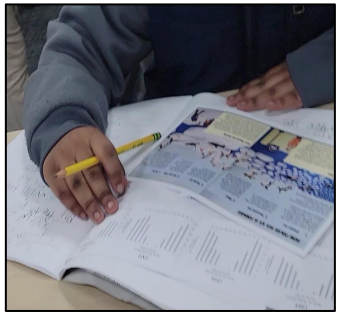


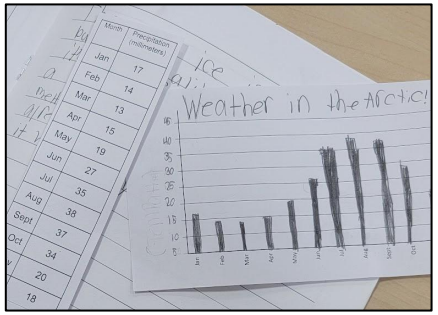


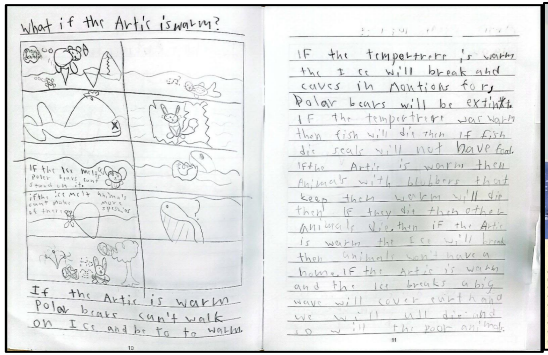
Courtesy scottieforeffectonscholars

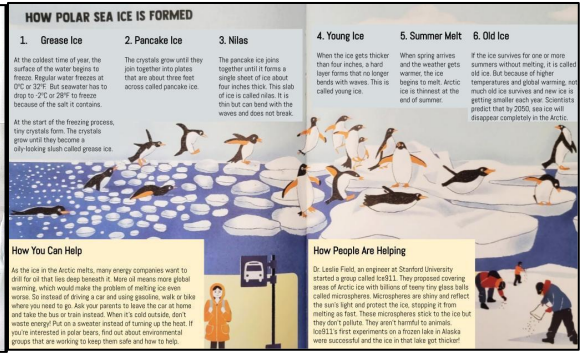
Weather, Climate, & Animal Survival in the Arctic

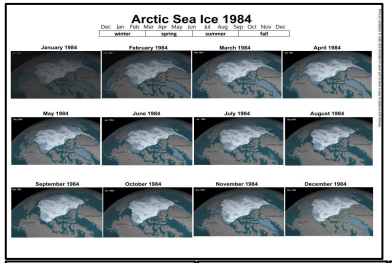


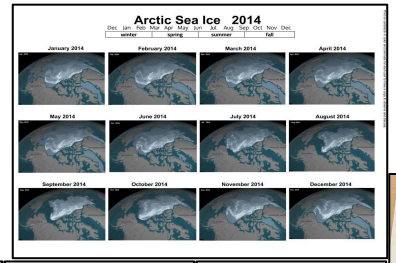


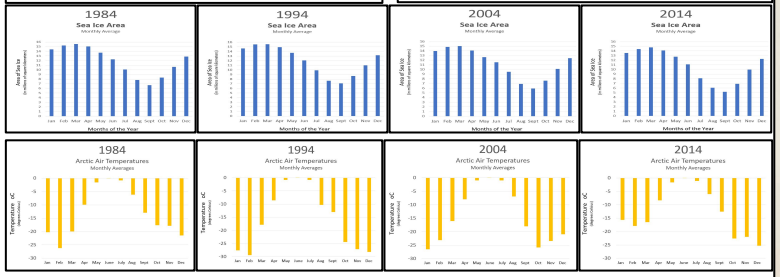


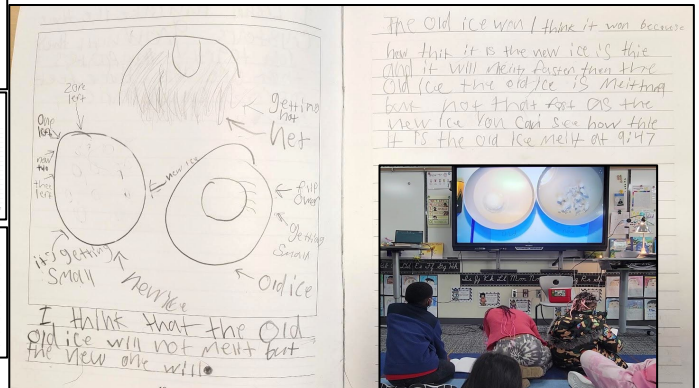




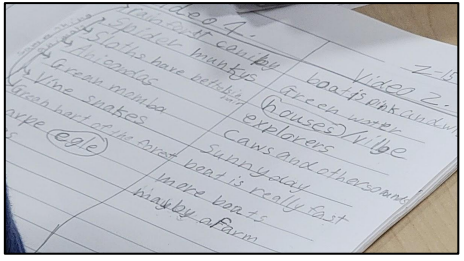


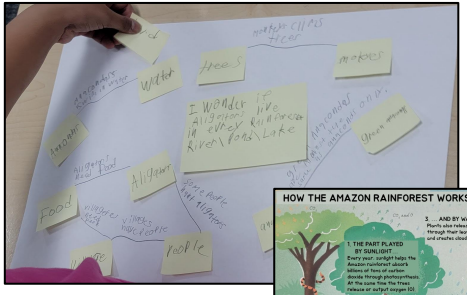


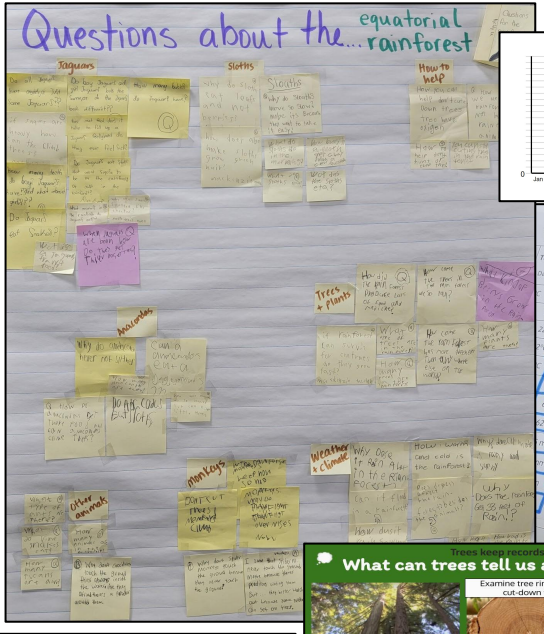


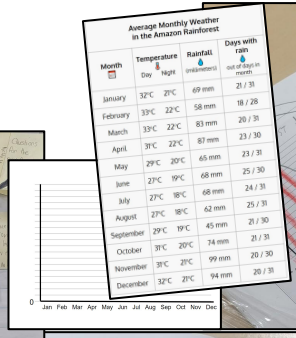


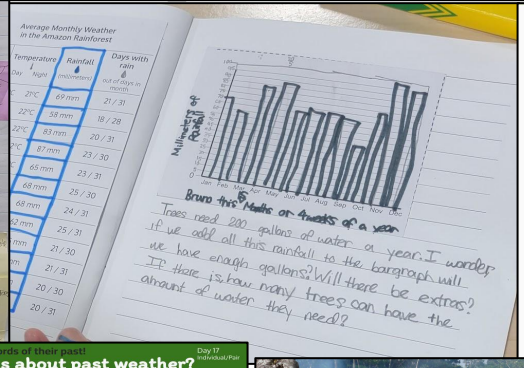
Weather, Climate, & Animal Survival in the Equatorial Rainforest





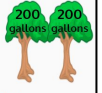




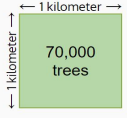


Rainforest Facts

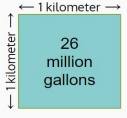
Each average sized tree in the rainforest needs about **200 gallons** of water **each year**.

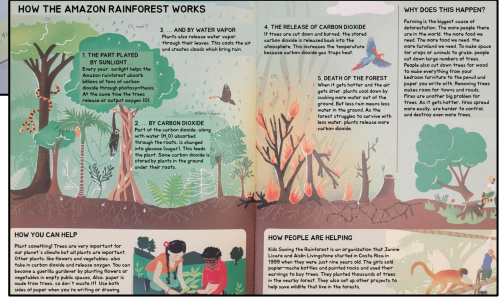


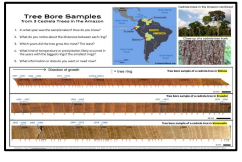
Scientists estimate the Amazon Rainforest has about **70,000 trees** in each 1 square kilometer.

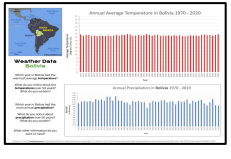


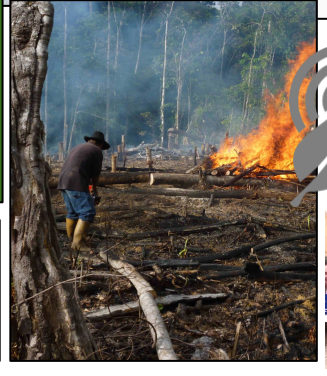
100 mm of rain over 1 square kilometer is about **26,000,000 gallons** of water.











RAINFOREST CONNECTION

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Extra Slide 19-20

Temporal outline of integrated unit & goals

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Grade 3 Example Unit

Weather, Climate, & Animal Survival

How do changes in weather and climate affect living things?

Study the Region
- Video tours of place
- Create web model of how things are connected
- Driving Question Board

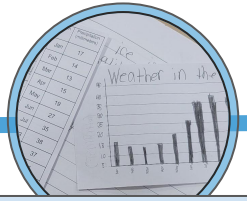
Estimate Habitat Area
- How do scientists find area?
- Interpret photos & graphs
- Why is area important?
- What factors change area?

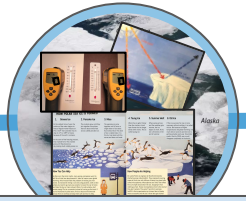
Weather & Climate
- How do scientists measure temperature and precip.?
- Make graph from data table
- Why is weather important?

Habitat Area Growth/Loss
- How does area grow/shrink?
- How does gain/loss relate to weather? relate to humans?
- What role does this habitat play in global weather?

Critique Solutions & Teaching Others
- Human Impacts
- Critique proposed solutions
- Teach others

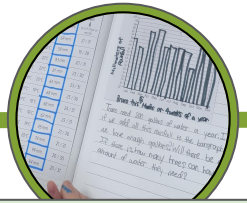
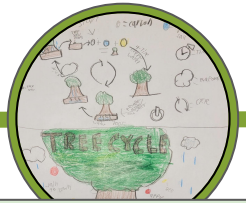
Arctic Region
Weeks 1-4





📚📝ELA: Polar animal research clubs & write non-fiction information books

Equatorial Rainforest
Weeks 5-8

📚📝ELA: Rainforest animal research clubs & write non-fiction information books

Art & Activism

Week 9

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Grade 3 Example Unit

Weather, Climate, & Animal Survival

How do changes in weather and climate affect living things?

Reading & Writing Lessons

Animal Research Clubs

READING GOALS: Non-fiction research-to-learn

- ❑ Read to learn about the world
- ❑ Build foundational research skills
- ❑ Synthesize info across texts
- ❑ Identify main idea + details
- ❑ Compare and contrast

WRITING GOALS: Non-fiction informational writing

- ❑ Elaboration - include facts, definitions, details, observations
- ❑ Organization - Write with different text structures in mind, grouped related information together
- ❑ Craft - Use expert lingo, descriptive language, interest reader, used drawings, captions, diagrams

SCIENCE GOALS: For specific animal, students will...

- ❑ Identify what they need to survive
- ❑ Describe their habitat
- ❑ Describe stages in their life cycle
- ❑ Identify predators and prey
- ❑ Describe physical traits
- ❑ Give examples of how traits and behaviors help animals get what they need from their habitat in order to survive

Science Lessons

Weather, Climate, & Habitat

Arctic & Equatorial Rainforest

For a specific region of the world, students will be able to...

- ❑ Identify differences bet. *weather* & *climate*
- ❑ Describe climates & habitats around world
- ❑ Display weather data in graphs and/or tables
- ❑ Interpret weather data in graphs and/or tables
- ❑ Make predictions about survival of animals in a particular region if:
  - (a) climate changes in their region or
  - (b) there is severe/unusual weather event
- ❑ Identify actions people can take to protect animals, habitats, climate

READING GOALS:
Non-fiction about weather, climate, careers

- ❑ Synthesize info across "texts"
- ❑ Compare and contrast

WRITING GOALS: Making sense of data

- ❑ Elaboration - facts, definitions, details, observations
- ❑ Craft - Use expert lingo, descriptive language, interest reader, used drawings, captions, diagrams

Math Mini-Lessons / Review

Constructing Scaled Graphs & Estimating Area

MATH GOAL:
Construct & Interpret Scaled Graphs

- ❑ Draw a scaled picture graph or bar graph to represent a data set (weather data)
- ❑ Interpret/read scaled bar graphs with units
- ❑ Calculate differences between data points to identify how much a quantity increased or decreased over time

MATH GOAL:
Calculate area & estimate totals

- ❑ Find the area of rectangles
- ❑ Estimate the total area of habitat in the rectangular photograph by adding parts together

CCSS.MATH.CONTENT.3.MD.B.3 *- Draw a scaled picture graph or bar graph to represent a data set*
CCSS.MATH.CONTENT.3.NBT.A.2 *Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.*
CCSS.MATH.CONTENT.3.MD.C.5.A *A square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.*
CCSS.MATH.CONTENT.3.MD.C.5.B *A plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.*