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| **Lesson Title : Our Local Environment** | **Unit #:**  **1** | **Lesson #:**  **1** | **Activity #:**  **2** |
| **Activity Title: Investigating Pollution** |

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| **Estimated Lesson Duration:** | **4 days (70 minutes)** |
| **Estimated Activity Duration:** | **1-2 days (70 minutes)** |

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| **Setting:** | **8th grade classroom** |

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| **Activity Objectives:** |

Students will…

* Collect, analyze, and graphical represent pollution (PM2.5 and Ozone) provided by the Air Quality Agency Ambient Air Monitoring Site in Batavia, Ohio.

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| **Activity Guiding Questions:** |

* What is air pollution?
* What are the causes of air pollution?
* How does air pollution affect the environment?
* How does air pollution affect our health?
* What is Air Quality Index?
* What kinds of pollutants are there?
* How do you measure air pollution?
* How much air pollution is in our area?

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| **Next Generation Science Standards (NGSS)** | |
| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☒ Patterns |
| ☐ Developing and using models | ☐ Cause and effect |
| ☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☐ Analyzing and interpreting data | ☐ Systems and system models |
| ☒ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function. |
| ☐ Engaging in argument from evidence | ☒ Stability and change. |
| ☒ Obtaining, evaluating, and communicating information |  |

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| **Ohio’s New Learning Standards for Science (ONLS)** |
| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☒ Recalling Accurate Science **(R)** |

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| **Common Core State Standards -- Mathematics (CCSS)** | |
| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☒ Useappropriate tools strategically |
| ☒ Reason abstractly and quantitatively | ☒ Attendto precision |
| ☒Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☒ Model with mathematics | ☒ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

Topic: Species and Reproduction

Standard: This topic focuses on continuation of the species.

Content Statements:

* 8.LS.1: Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.
* 8.LS.2: Reproduction is necessary for the continuation of every species.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

* 1.1.2a Ambient Air Quality PPT
* 1.1.2b Scientific Explanation Graphic Organizer
* 1.1.2c Map of Southeast Ohio
  + Include at least Cincinnati, Batavia, Felicity, and areas north and east of Batavia.
  + Use a large format printer to create a class set of them.
  + Eliminate them for future use which allows students to interact (write on) if needed.
* 1.1.2d Batavia Monitoring Site Air Quality Data for PM2.5
  + Excel spreadsheet so students can create graphs within Excel or Google Sheets.
  + I chose to use data prior to 2015 because that is when Beckjord was still operating.
    - Air Quality Agency Ambient Air Monitoring Site Data from Batavia, Ohio
    - Contact person Anna Kelley, Monitoring and Analysis Supervisor at

(513) 946-7725.

* 1.1.2e Wind Direction Grid
  + Create a class set copied on transparent paper
  + Use a large format printer if possible or just make the copies bigger
  + Adapted from <https://www.tes.com/lessons/GFJt5AOeIjVaag/weather>
* Smartboard or projector
* Computers
  + excel or Google sheets
* Graph paper and colored pencils if computers are unavailable.
  + I will have students use excel or Google sheets tools to represent their data.
* Maps of Southeast Ohio that includes at least Cincinnati, Batavia, and Felicity.
  + Use a large format printer to create a class set of them.
  + Eliminate them for future use and it allows students to interact (write on) with the graph if needed.
* Dry erase markers

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| **Teacher Advance Preparation:** |

* Display 1.1.2a Ambient Air Quality PPT
  + Contact local Air Quality Agency to see if they have any resources you need such as a PowerPoint.
* Print 1.1.2b Scientific Explanation Graphic Organizer
  + One per person
* Print 1.1.2c Map of Southeast Ohio
  + Use a large format printer to create a class set of them.
  + Provide a class set (one per group)
  + Eliminate them
* Share the spreadsheet data with students (1.1.2d Batavia Monitoring Site Air Quality Data for PM2.5) digitally.
  + Note: If the data provided does not match your area, contact your local Air Quality Agency or County Department of Environmental Services.
    - Compile the data in if then statements to match a grid for wind direction. See the code below for an example:
      * =IF(C6<=90, "NORTHEAST", IF(AND(C6>90,C6<=180), "SOUTHEAST", IF(AND(C6>180,C6<=270), "SOUTHWEST", "NORTHWEST")))
* Print a class set (one per group) of 1.1.2e Wind Direction Grid on transparent paper.

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| **Activity Procedures:** |

1. Present 1.1.2a Ambient Air Quality PPT to the students.
   * The PPT contains the following information:
     + Services provided by Hamilton County Department of Environmental Services
     + Monitoring & Analysis Section
     + Purpose of National Ambient Air Quality Standards
     + Health Effects
     + Welfare Effects
     + National Ambient Air Quality Standards for pollutant types
     + Sources of Pollutants
     + Information on particulate matter
     + Air Quality Index
     + Information on ambient monitors including types
     + Information on black carbon
   * If possible, have Anna Kelley (Industry Partner for RET) visit the classroom and deliver the presentation.
2. After the presentation, provide students with 1.1.2b Scientific Explanation Graphic Organizer and 1.1.2c Map of Southeast Ohio.
3. Ask students to make a prediction to the following question:
   * Where are the major contributors to fine particulate matter (PM2.5) located in relationship to the monitoring site?
4. Once students provide a prediction on the Scientific Explanation Graphic Organizer, have them open the spreadsheet (1.1.2d Batavia Monitoring Site Air Quality Data for PM2.5).
5. Students will need to find the averages for each wind directions PM2.5 value. This can be done using the average function. Have the students figure out how to do it themselves. If they can’t get it, help them out. Below is the directions on how to do it in Excel and Google Sheets.
   * Excel: Calculate the average of numbers in a contiguous row or column
     + Click a cell below, or to the right, of the numbers for which you want to find the average.
     + On the Home tab, in the Editing group, click the arrow next to AutoSum , click Average, and then press Enter.
   * Google Sheets: To create a function using the Functions button:
     + Select the range of cells you want to include in the argument. ...
     + Click the Functions button and then select the desired function from the drop-down menu. ...
     + In the cell directly below the selected cells, the function appears.
     + Press the Enter key on your keyboard.
6. Students will need to create a bar graph of their results. The graph should include the PM2.5 values of each wind direction. Student will need to provide the following components on the graphs:
   * Axis labels
   * Units
   * Data
   * Title
   * Legend
7. Students will need to determine the wind direction the greatest amount of pollution is coming from such as NNE, ENE, ESE, SSE, SSW, WSW, WNS, and NNW.
8. On the Scientific Explanation Graphic Organizer, students will complete the evidence portion. They will need to provide the wind direction with the greatest amount of pollution coming from it. I suggest having them include the wind direction and amount of pollution coming from it. Remind them to use the correct units.
9. Provide students with 1.1.2e Wind Direction Grid that is printed on transparent paper. Using a dry erase marker, have them lighted shade in the wind direction area that has the greatest air pollution.
10. Have them place the Wind Direction Grid onto the map. The origin of the grid should be placed on Batavia because that is where the air pollution monitoring station is located.
11. Have them complete the remainder of 1.1.2b Scientific Explanation Graphic Organizer. The claim is will be something like “Cincinnati is the greatest contributor to fine particulate matter in Southwest Ohio.” Students will need to do additional research to determine why Cincinnati is the greatest contributor. The reasoning can be because of the amount of industries, roads, population, etc. They need to tie back their reasoning back to what PM2.5 is and what causes it.
12. Once they are finished with the graphic organizer, they will need to submit a final write up which includes the claims, evidence, and reasoning (CER) portion. They will need to complete it in paragraph form. This can be done by typing or writing; it is up to the instructor and is based on computer availability.
13. If students finish early, provide an extension (1.1.2f Extension Activity for Batavia Air Monitoring Site PM2.5 data). Have students create one of the following based on their learning level.
    * histograms of the PM2.5 based on wind direction; for example, one histogram for South-South-West (SSW), etc.
    * sunburst charts or wind rose chart looking at frequency of PM2.5 concentrations from each wind direction.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

* 1.1.2 b Scientific Explanation Graphic Organizer
  + Complete written explanation (paragraph form) which can be handwritten or typed.
* 1.1.2c Batavia Monitoring Site Data
  + Completing data collection (finding averages) and creating graphical representation (bar graph)
* 1.1.2d Extension Activity
  + For students that are more experienced in creating digital graphs

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

* Post-Assessment (given at the end of the unit) 1.1.1a
* Group Presentations with rubric (at the end of the unit) 1.2.5b
* Cooperative Learning Self Evaluation & Peer Evaluation Form 1.2.5c

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

* Place students in small heterogeneous groups (3-4) if possible or groups based on their leadership skills.
* Encourage students to ask their peers before asking a teacher.
* Developed graphic organizers for the students to use during data collection.
* Students can be given sentence starters for each section.
* Allow Algebra students to complete histograms for extensions.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

Successes

* I ordered a map of Ohio that was eliminated. The map I ordered was displayed more towns, roads, highways, etc. I was unable to unload it due to copyright laws therefore I provided a simple public domain map of Ohio.
* Students love the fact they could write on the map and the wind direction grid with markers. I noticed they would annotate all over the map. I could hear all kinds of conversations about things on the maps such as towns, roads, rivers, etc.
* At first students felt overwhelmed when they saw all of the data. They thought they were going to have to use a calculator to find all of the averages. Once students figured out how to use Google Sheets formulas and charts, they realized how easy it was to create graphs using this method. They thought it was much easier than hand creating them.
* Trying to teach all students at one time how to use Google Sheets for formulas and graphs can be a bit much. Students were learning at different rates so to keep my sanity, I created a module on Schoology that walked students through the steps of formulas and graphs on Google Sheets. These can be set up as stations if needed; for example, one station for finding out how to implement the average formula, one station for creating a graph in Google Sheets, and one station for modifying the components of a graph. I used videos I found on YouTube to help me with this process. You can also create your own videos for the students. They would enjoy this more but due to time constraints and last minute modification, I was unable to do this.
* My students have trouble completing tasks that have multiple steps therefore to keep them on track and from feeling overwhelmed, I revised the data sheet. Before all of the information was on one sheet and now the revision has two sheets: Wind Direction Data (Calculate Averages) and Bar Graph. The directions are highlighted on each one to help them to determine what is being asked of them.

Shortcomings

* The essential question was “What are the major contributors to fine particle matter (PM2.5) in Southwest Ohio?” The monitoring site is unable to differentiate where the pollution is coming from. It can only identify in what general location the pollution samples are coming from therefore I changed the question to “Where are the major contributors to fine particulate matter (PM2.5) located in relationship to monitoring site?” Students can provide examples of what could be causing the pollution in their reasoning.
* Many students have never seen a printed map of Ohio before. They had trouble finding specific locations of it. We took some time out of instruction just to explore the map and go over the components of it.
* Students attempted to place the origin of the wind direction on Felicity, Ohio because that is where they live. They had to be redirected to find the location of the monitoring site which is Batavia, Ohio.
* Students were not sure what the evidence would look like in the graphic organizer. They did not realize it was the numerical value and wind direction. They just wanted to provide the location of something for the evidence.
* Not as many students were able to complete the extension activity. I believe this is due to the majority of the students have never used Google Sheets before therefore they did not get finished before anyone else.