

Lesson Outline for ALEX

General Lesson Information

Title: Spring into Data Literacy

Overview/Annotation- The objective of this lesson is to help students develop basic skills in data collection, analysis and interpretation. The lesson (which can be broken up over days or weeks) has students collect categorical and numerical environmental data outdoors, which they then will graph in the classroom. They will then practice communication skills by writing a paragraph describing their findings and/or presenting a graph to the rest of the class.

The suggested data collection for the lesson plan is for students to use quadrats to collect data about dandelions growing in grass around school. However, this can be modified to collect any kind of controlled environmental data (including other weeds like clover or violets)– the goal is to teach them about data collection/ analysis and get them outside! In the fall, you can use quadrats to count the number of leaves per square meter. Any time of year, you can count the number of twigs and sticks on the ground.

Setting or format (outdoors, in groups, lab, etc.): The data collection part of the lesson is outdoors and can be done as a whole class or in small groups. The remainder of the lesson can be done in the classroom. If laptops or a computer lab is available, the graphing portion could be done in Excel rather than on graph paper. The work can be done in groups, but the goal is for each student to independently develop their own graphs and interpretation of the data.

Intended group size (if groups are used): This would be best with smaller groups (2-4).

Intended grade level(s): 6-12

Approximate Time of Lesson (*Ideally break down into 20-50 minute periods*): The lesson has 4 parts, and each part should take about 45 minutes.

Researcher Biography

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Brief Description of Research Interests: I study carbon and nitrogen cycling in wetlands. Wetlands play an important role in storing carbon (good for climate change mitigation) and removing nitrogen (which contributes to algal blooms), but human activities have impacted health. I study how different human stressors (e.g. land use change, oil spills) affect the ability of wetlands to store carbon and remove nitrogen.

Associated Standards and Objectives

Content Standards- *List Alabama Course of Study Standards that connect to lesson*
This lesson does not support a specific study area, but is instead designed to develop skills in data collection, interpretation, and analysis, a required component of many of the study areas.

Primary Learning Objectives- Students will be able to:

- 1) Collect data in a systematic way
- 2) Differentiate between types of data, e.g. categorical vs. numeric, independent and dependent variables
- 3) Calculate basic descriptive statistics: mean, median, mode, range
- 4) Determine the best way to depict different types of data graphically
- 5) Interpret graphical data and communicate the findings in writing and/or orally

Additional Learning Objectives- *Any learning outcomes that are not directly related to the content standards but may relate to other local or national standards*

Preparation Information

Total Duration- The lesson is broken down into 4 parts that each take about 45 minutes. The teacher can increase the number of data collections (Part 2) to add a temporal aspect (if they choose).

Materials and Resources-

*provided by researcher

Part 1: Introduction

- Powerpoint (or their own lecture material)*
- Quadrats
- Datasheets*
- Data Planning Worksheet*

Part 2: Data Collection (this will vary)

- Datasheets*
- Quadrats
- Pencils
- Clipboards
- Other tools: ruler, tape measure, thermometer, stopwatch
- Graph Plan Worksheet*

Part 3: Data Analysis

- Graphing paper and circle paper (for pie charts)*
- Notepaper for calculating descriptive statistics
- Pencils
- Colored pencils/ crayons

Part 4: Interpretation and Communication

- Graphing/ circle paper for final graph*
- Notepaper for descriptive paragraph draft
- Colored pencils/ crayons
- Pen or pencil
- Example graphs with descriptions*

Technology Resources Needed-

- Optional: laptop/ projector (Lecture materials will be provided as powerpoint presentations)
- Optional: Computer/ laptops for students to do graphs in Excel

Background and Preparation- *Description of information (science content, use of materials, etc.) teacher and/or students will need to know prior to this lesson; list steps for any preparation prior to the lesson*

- A quadrat is a frame, usually square, used by ecologists to isolate a standard unit of area for study of the distribution of an item over a large area. A good size for this activity would be 0.5 m x 0.5 m (~20 in x 20 in)
 - Quadrats can easily be made with cardboard and an exacto knife. In the past I've cut them out of boxes and reinforced them with duct tape. An alternative would be to use AWI funding to construct quadrats out of PVC pipes.
 - At a minimum, I can provide instructions for making quadrats, though I would like to not have the burden of this on the teacher.



- Using a quadrat: The goal is to randomly sub-sample a study area to collect data to scale up. So, the quadrat should be placed at random in the study area. **This can be achieved by gently tossing the quadrat like a frisbee or an underhand throw.**
- Prior knowledge on graphing and basic statistics calculations would be helpful for the teacher.
 - <https://sadlerscience.com/graphing-data-in-an-ngss-classroom/>
 - <https://sadlerscience.com/using-google-sheets-to-create-graphs/>
- The assumption with this activity is that the students have limited prior experience/ knowledge of the subject
- If computers are available, making the final graphs in excel would be a good skill test for the students. I'm happy to work with teachers to develop a tutorial to guide students through the process.
- This experiment has a lot of built-in flexibility in terms of what is measured and how often measurements are repeated. I've suggested alternatives to counting dandelions, but teachers can reach out if they guidance on something else. I tried to minimize the supplies required so that this can be done at a low cost and/or adapted for remote learning.

Procedures and Activities Part 1: Introduction

Part 1 introduces students to the lesson concepts. They will learn about different types of data and graphs. The teacher will demonstrate how to use a quadrat, fill out a datasheet, and make a graph. Students will also plan what type of data they will collect in Part 2.

Engagement (sparking interest, introducing phenomenon, engage students' everyday experiences):

- The teacher will deliver a short lecture on the core concepts of the lessons: types of data, types of graphs, and descriptive statistics.
- Next, the teacher will introduce the data collection activity and provide a list of basic variables that will be measured. As a class, the students will determine what type of data each variable is, and brainstorm types of data to be collected.

Main activity (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)

- The class will go outdoors and the teacher will demonstrate how to use a quadrat and fill in an example datasheet
 - Face the study area. Gently toss the quadrat (underhanded or like a frisbee) into the study area. The spot where the quadrat lands is the spot that will be measured.
 - Count the number of dandelions within the quadrat and record
 - Repeat two more times
- Back in the classroom, the teacher will calculate descriptive stats for the data collection and make an example graph.
- In groups or individually, students will complete a Data Planning worksheet where they write down the variables they plan to measure, how they might vary what they are measuring (e.g. sun vs. shade, distance from building), what tools they will use, and predict what graph types will be used to depict each data type. Ideally teacher will provide feedback before Part 2.
- Reflection: Why is it important for everyone to collect their data with the same methods? (Answer: so that we can compare datasets knowing that differences in dataset are not due to differences in methods)

Wrap up and Reflection (wrap up activity, reflecting on learning, informal assessments of student learning)

- Students write down one thing they learned and one question they have about the lesson

Final product/Summative evaluation (e.g. quiz, presentation, essay, etc., may occur during a later class period)

- Completed Data Planning worksheet. Ideally teacher will provide feedback before Part 2.

Procedures and Activities Part 2: Data Collection

Part 2 is designed to be very flexible so that teachers can adapt to what is available to them. I have written this for doing observations on dandelions because they are ubiquitous and easy to identify, but there are many other approaches teachers can take. What is important is that 1) the data are collected using a standard approach and 2) there is a combination of numerical and response variables.

One thing that teachers might want to consider is having students collect data more than once or over several weeks. It might be interesting to do dandelion bloom counts over the course of February/March/ April to see if there are blooming patterns. However, even dedicating just one day should be sufficient for students to get experience collecting and interpreting data.

I have listed potential alternative activities at the end of this sheet and am happy to work with teachers to develop other activities.

Engagement (sparking interest, introducing phenomenon, engage students' everyday experiences)

- Lesson starts with teacher-led quick review of variable types and descriptive statistics
- Groups/ individuals gather their datasheets and tools needed
- Teacher does a final check-in with the class to see if there are any questions

Main activity (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)

- Students use quadrats to collect data about dandelions
 - Toss the quadrat to randomly select a spot within the study area as described in part 1. Students may choose to vary their study areas based on some variable (e.g. sun vs shade, different distances from a building or tree, location on a slope)
 - Collect and record the data based on the variables previously selected to measure.
 - How many dandelions?
 - How many dandelions are open/ closed/ puffballs?
 - How tall is each dandelion?
 - What is the weather (sunny/ cloudy/ rainy/ windy)?
 - What is the temperature?
 - How many dandelion blooms inside the quadrat are visited by a bug in 5 minutes?
 - Repeat – suggest doing at least 3 quadrats worth of data collection
 - If this is done in groups of 3, students can alternate between being the quadrat tosser, data collector, and data recorder.

Wrap up and Reflection (wrap up activity, reflecting on learning, informal assessments of student learning)

- Return to classroom and put away supplies

- Class discussion: What were some of the challenges in collecting your data? Were you able to collect everything you planned? If not, why not? Is there something else you think you could have measured?
- Students fill out a Graph Plan Worksheet where they describe three graphs they will make from their data (i.e. types of data used, types of graphed, what will go on the axes)

Final product/Summative evaluation (e.g. quiz, presentation, essay, etc., may occur during a later class period)

- The completed Graph Plan Worksheet.

Procedures and Activities Part 3: Data Analysis

The purpose of Part 3 is to help students develop graphing and data interpretation skills. At the end of the class, students will have calculated the descriptive statistics for their data and generated two different types of graphs from their data.

Depending on how data collection, teachers might want to consider pooling data between groups or across the class. Another option is to pair up individuals or groups to swap datasets for one of their graphs.

This work can be done individually or in groups, but each student should make their own graphs.

Engagement (sparking interest, introducing phenomenon, engage students' everyday experiences)

- Quick review of how to determine mean, median, mode, and range

Main activity (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)

- Students calculate the descriptive statistics for their data
 - If they can, they should do these for different categories. For example, if they did 2 quadrats in the sun and 2 quadrats in the shade, they could calculate these values for sun and shade and compare them. This is where pooling data between groups could come in handy.
- Students create their graphs on graph paper or in excel

Wrap up and Reflection (wrap up activity, reflecting on learning, informal assessments of student learning)

- Class discussion of their findings
 - Scatter/ line plots: Does anyone see any relationships between their independent variable and their dependent variable?
 - Bar graphs: Did anyone see their dependent variable differ between categories?
 - Where is the mean compared to the bars?
 - Pie charts: Were any wedges bigger? What wedges were those?

Final product/Summative evaluation (e.g. quiz, presentation, essay, etc., may occur during a later class period)

- Students will select one graph of those they made to be their final presentation graph and turn it in for feedback from the teacher

Procedures and Activities Part 4: Interpretation and Communication

In Part 4, students will do a final copy of their selected graph. They will then summarize their findings in a short paragraph (~3 sentences) and orally. This can be either through presentation to the rest of the class, or by sharing with small groups. The goal is to help students become comfortable writing about numbers.

Engagement (sparking interest, introducing phenomenon, engage students' everyday experiences)

- Quick introduction to the day's activity, teacher provides feedback and answer questions
- Teacher shows example graphs with descriptions to introduce the written portion
- Questions to think about:
 - What will you write if you don't see a pattern? (the independent variable did not have an effect on the independent variable)
 - What are good descriptive words or phrases to use? (greater than, less than, if/then, positive/ negative relationship)

Main activity (suggest possible reflection or comprehension questions along with examples of correct answers or common misconceptions)

- Students remake their final graph, incorporating teacher feedback
- Students draft a short paragraph describing their graph
- Students describe their graphs and their interpretation to each other/ to the class, using their paragraph as a guide

Wrap up and Reflection (wrap up activity, reflecting on learning, informal assessments of student learning)

- Students use time to edit their paragraphs based on peer feedback
- Discussion: What changes will you make? Why will you make these changes? If you had to do this again, how would you do it differently?

Final product/Summative evaluation (e.g. quiz, presentation, essay, etc., may occur during a later class period)

- Students write final paragraph describing their data under their final graph and turn in for assessment.
- Answer: favorite thing, least favorite thing, what do you still have a question about?

Attachments- *Any materials for the lesson such as video links, worksheets, etc., listed here*

- Powerpoint for Part 1
 - Data Planning Worksheet
 - Datasheets
 - Graph Plan Worksheet
 - Quadrat Instructions
 - Graphing paper and circle paper
 - Example graphs with descriptions
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- Extension idea? Use a measuring tape to set a 10 m line from the tree trunk. Have students walk along the line and measure the length and circumference of any sticks they encounter. Does it differ between types of trees? Measure the circumference of the tree at chest height – does that make a difference?