**Problem Posing for Vostock Ice Core**

**Module Overview**: We have a dataset from the Vostock Ice Core where several atmospheric factors are reconstructed over 400,000 years. Note that the current exercise has several quantitative/data goals already, but it is very “closed” in that all questions have an exact right answer (and all student output looks exactly the same, or it is wrong).

**Setting**:

This is a lab in an upper-level Global Change Ecology class. Students at least have taken foundations of biology (ecology and evolution unit), but come from many different sectors.

**Learning Outcomes for the activity-**

* *Initial learning outcomes:*
  + to understand how past atmospheric conditions are reconstructed from ice cores
  + to have students convert one metric (deuterium isotopic ratios) into a more informative metric (temperature)
  + to have students create their own graphs from data
  + to understand the relationship between carbon dioxide in the atmosphere and temperature over long time periods
  + To understand how to extrapolate values from models
* *Potential learning outcomes to add (to make the activity more “open”):*
  + Have students figure out how to convert metrics for interpretive ease (deuterium to temperature)?
  + Have students ask their own question from data
  + Understand the pitfalls of making predictions from data and how to validate them

How does data acumen align with this learning outcome?

* I put an “o” in the table to show original learning goals
* I put an “\*” in the table to indicate new learning goals under a revised exercise

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| --- | --- | --- | --- | --- | --- |
| **Quantitative Pillars** |  | **Data Life Cycle** |  | **Social/Pedagogical Concepts** |  |
| Mathematical | x | Data import |  | Communication | \* |
| Computational |  | Management |  | Equity, Diversity, Inclusivity |  |
| Statistical thinking | x | Curation |  | Universal Design for Learning |  |
| Reproducibility |  | Analysis | x | Ethics |  |
|  |  | Sharing/ Reporting | \* |  |  |

**Activity/Module**:

Describe the activity-

* Students are given a small dataset showing several metrics at different depths from the Vostok ice core and a worksheet with a series of questions to answer. They answer the questions directly onto the worksheet and embed any graphs.

Course type: Lab

Pedagogy: Lab activity

Describe the data and the tools used to interact with the data:

* The data is a very small, simple excel spreadsheet (7 columns, 194 rows) and calculations are done on the spreadsheet into a new column. Then graphs are made and simple models developed within excel (e.g., draw regression line and generate R-2 value and then extrapolate)

Describe where problem posing will be used and how you as the instructor will use problem posing to shape the activity-

* What is the Question Focus?
  + Add a question about the impact of various environmental forcers on temperature (carbon dioxide, methane, dust) – and have them do their own data exploration
  + The last question on the current exercise (Can you think of a measure of temperature that might be a better comparison?) was not a successful question (most students just said “no”). Instead, I would reword to:
    - What would be a better temperature metric to compare to your prediction?
    - Find that value of that metric on the internet as best as you can and compare to your prediction.
    - Did it perform better than today’s temperature? Why or why not?
* How is the Question Focus introduced?
  + I guess I would just revise the worksheet to include those questions and be there in order to help them. I haven’t thought about the logistics of the impact of the various environmental forcers – and I haven’t thought yet about how I would structure that question (I would definitely need to add some guidance).

Describe the student products:

* Results of analysis on environmental forcer (question, model, results)

**Assessment**:

How will this learning outcome be assessed?

* Worksheet is graded

Will students practice this skill again?

* Yes, this is the first activity in the class and is done in excel. Future exercises are in R and I want to find some good ways to transition from excel to R. I might have a day where we redo this entire exercise in R to see how it is done differently. That would allow me to more gently build to future exercises that require more data management and R skills.

In what setting?

* If we redid in R, it would be the same topic but would actually allow us to do a bit more statistics (I don’t do statistics in excel) and they could expand on the environmental forcers question. (Maybe present in this class – or add the question in this class?)
* Other classes that would build on these skills is a whole unit on phenology, we collect data on phenology and analyze the patterns and do some statistics.

**Extra information**:

What will students need to know before completing this activity?

* Hopefully they know how to use excel!!