Science and Engineering Practices

Classroom practices that support proficiency

Asking Questions and Defining Problems 1. Ask "What (kinds of) questions about this phenomenon could we answer with an experiment?" 2. Brainstorm on sticky notes all possible questions about a phenomenon, T chart as a class which questions could be answered and which questions cannot be answered with today's technology or with the materials and time we have available. 3. Examine models and identify their limitations and/or weak points 4. Define what (Materials, Resources, Learning) is needed to solve a particular problem, or what would be needed to answer a specific question. 5. Analyze preconceptions about a phenomenon (Note preconceptions at the start, after exploration revisit preconceptions for analysis) 6. Have students ask clarifying questions about other students' experimental designs, or projects, or data
Developing and Using Models 1. Have students create a model of a system that they revisit, refine, and edit throughout the unit. 2. Compare and contrast different student created models for the same phenomenon. 3. Identify and explain weaknesses or limitations in published (curriculum, web, or even student etc) models. Identify and explain strengths. 4. Explain how a student-created model relates to a real world situation. 5. Use a model to predict changes in a real world situation.
Planning and Carrying Out Investigations 1. Have students design their own experiment to learn about a phenomenon a) given specific material and time constraints and/or b) given no constraints 2. Have students write their experimental design changing just one variable, and analyze each others designs. 3. Analyze written lab procedures for accuracy 4. Conduct a pre-written experiment and then have students choose and change a different variable for the same experiment.
Analyzing and Interpreting Data 1. Have students analyze data from the newspaper - eg. tide charts, moon phases, populations in order to uncover patterns 2. Have students create graphs of data they have generated, discuss the correct type of graph to use in each situation 3. Create two graphs - one with a saw tooth and one without and discuss how the graphs are similar and different and what conclusions people might draw when viewing the data. 4. Interpret results from an experiment using CER - Claim-Evidence-Reasoning 5. Ask "How could this data be used to predict…"

Created by Alicia Payton-Miyazaki & Ian Kastelic

6. Ask "What are outliers in the data and what do they show?"
7. Ask "What are limitations of this data based on the experimental design?"
8. Ask "How would the interpretation of this data change if we eliminated some of the data?" (Example - remove 5 pieces of data from an extreme or 5 pieces that do not fit the pattern - discuss cherry picking/manipulation of data)
9. Create a graph from a set of data with the purpose of minimizing the appearance of change. Repeat with the intent of maximizing the appearance of change. The find real-life examples and discuss the creator's intent.
10. Use a created graph to extrapolate further results
11. Use a created graph to interpolate a condition not identified through the given data

Using Mathematics and Computational Thinking

1. Organize data into tables and graphs
2. Describe patterns mathematically
3. Creating flow charts for cause and effect
4. Use rates, proportions, ratios, and percentages in discussions about data from tables or graphs
5. Convert data in tables into appropriate graphs
6. Calculate percent effectiveness of a model or system and optimize. Use data to support evidence that your new design is optimized.
7. Estimate or predict before, then discuss your accuracy of results after an experiment.

Constructing Explanations and Designing Solutions

1. Using CER - Claim-Evidence-Reasoning template to organize results of an experiment
2. Build and refine models and have students explain what new knowledge or understanding was gained through the process
3. Project/Problem Based Learning as a means of understanding a phenomenon
4. Design Thinking around scientific problems
5. Ask "What would be the components of a successful design solution to this problem? And create a rubric.
6. Ask" How could we optimize this design?" Re-design and have students describe the features they changed & how those changes optimized their project.

Engaging in Argument from Evidence

1. Present students with numerous pieces of data about a topic. Some contradictory, or vague. As a class have students evaluate which pieces of data are most relevant and accurate and why.
2. Have students engage in an class debate after gathering evidence from experiments they designed about phenomenon, debating what their data proves
3. As a class create a rubric for a successful design to solve a problem. Have students use design thinking to create a solution, share design solutions and have the class write or orally argue about how well different designs meet the rubric using evidence.
4. Use CER - Claim-Evidence-Reasoning
5. Host a scientific debate about a current scientific situation in the news. (Should vaccines be required for all students to attend all schools? Is the money spent on the Mars rovers better used elsewhere?)
6. Make a padlet that is divided into Pro and Con for a topic and allow students to post

evidence to either side and comment on either side
Obtaining, Evaluating, and Communicating Information 1. Read text, charts, graphs, and models and discuss, as a whole class, what conclusions they can draw from the data. 2. Demonstrate comprehension of a graph by changing it into a data table or representing the data in a different way 3. Apply information from text, charts, graphs or models to the students own model and revise their own model and show those changes in a specific color 4. Have students do a science project and create a presentation or infographic 5. Prepare a written or oral presentation gathering and synthesizing information from different types of media sources. 6. Read about and debate opposing views on a scientific issue, and use data from experiments or research to determine which position is stronger. 7. Have 2 students in the class research and debate opposing views on a scientific issue. Then, using the debaters' data have a class discussion on whose position had better corroborating data.