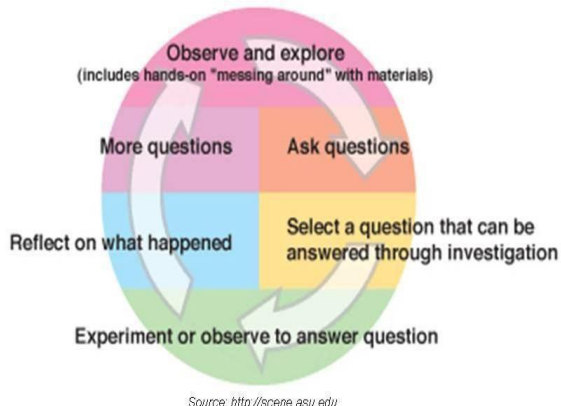


eCYBERMISSION recommends all participating teams utilize three similar investigative techniques when approaching all aspects of the Mission Folder, from start to finish. While all investigative techniques are similar, they each feature some unique differences as well and may vary slightly in content from what you're currently familiar with in the classroom. If you follow these three techniques carefully, you will undoubtedly be successful with both your Mission Folder and in future experimental endeavors.

Understanding Scientific Inquiry

The National Science Education Standards define scientific inquiry as “the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.” Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions.



When applying the method of scientific inquiry, students should follow the steps throughout their experimentation:

1. **OBSERVE AND EXPLORE** - What do you already know and what do you want to know?
2. **ASK QUESTIONS** - Think about things that you notice, and then expand on what you “wonder” about these items.
3. **SELECT A QUESTION THAT CAN BE ANSWERED THROUGH INVESTIGATION** - Review the items of “wonder” regarding different topics of interest. Choose one of these items that can be solved through testing and experimentation, and form a hypothesis to test this theory.
4. **EXPERIMENT OR OBSERVE TO ANSWER QUESTION** - Conduct an experiment to test the question at hand.
5. **REFLECT ON WHAT HAPPENED** - Describe what happened during the experimentation, reporting these findings through tabulating, graphing, etc.
6. **MORE QUESTIONS** - Now that your theory has been proven or disproven, what other results and experimentation could result from this? Conclusions often lead to more questions and will increase the chance for further discovery!

The National Science Teaching Association (NSTA) has adopted this method of teaching because it helps develop a deep understanding of science and serves as a powerful way to help students understand the natural world. When implementing scientific inquiry, NSTA recommends that teachers help students understand:



- That science involves asking questions about the world and then developing scientific investigations to answer their questions.
- That there is no fixed sequence of steps that all scientific investigations follow. Different kinds of questions suggest different kinds of scientific investigations.
- That scientific inquiry is central to the learning of science and reflects how science is done.
- The importance of gathering empirical data using appropriate tools and instruments.
- That the evidence they collect can change their perceptions about the world and increase their scientific knowledge.
- The importance of being skeptical when they assess their own work and the work of others.
- That the scientific community, in the end, seeks explanations that are empirically based and logically consistent.

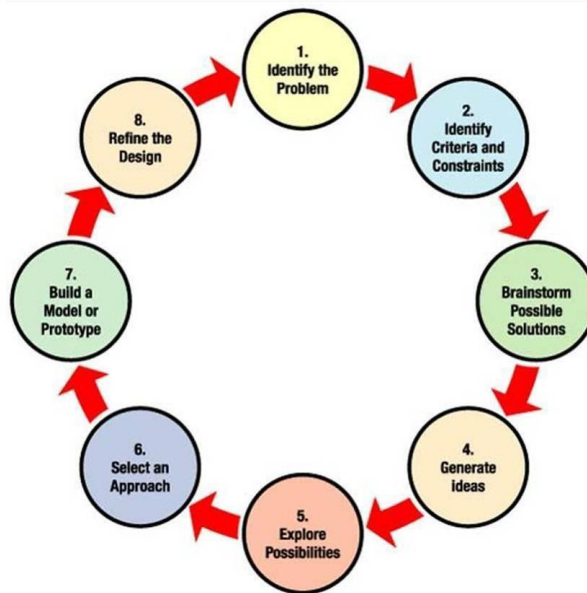
What are Scientific Practices?

The Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas introduced the science and engineering practices that were then adopted as part of the Next Generation Science Standards. The purpose of the scientific practices is to encourage students to think of science as a process with no set order or method. The practices indicate that not only is skill required, but knowledge as well. The practices are:

1. **Asking Questions:** Asking what exists and what happens. Why does it happen? How does one know what is happening?
2. **Developing and Using Models:** Modeling tools such as diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas.
3. **Planning and Carrying Out Investigations:** Investigations are systematic and require clarifying what counts as data and identifying variables or parameters. These investigations are conducted in the field or laboratory, working collaboratively as well as individually.
4. **Analyzing and Interpreting Data:** Data produced by scientific investigations must be analyzed in order to devise meaning. Since data patterns and trends are not always obvious, a range of tools can be used including tabulation, graphical interpretation, visualization and statistical analysis. Scientists must also identify sources of error in the investigation and determine the certainty of the results.
5. **Using Mathematics, Information and Computer Technology, and Computational Thinking:** Mathematics and computation are used for constructing simulations, solving equations and recognizing, expressing, and applying quantitative relationships. These mathematical and computation approaches can help predict behavior of systems and validity of those predictions.
6. **Constructing Explanations:** The goal of science is the construction of theories that provide explanatory accounts of the world.
7. **Engaging in Argument from Evidence:** Argumentation is the process by which evidence-based conclusions and solutions are reached.
8. **Obtaining, Evaluating, and Communicating Information:** Scientists must be able to communicate their results clearly and persuasively. Communicating information can be done in multiple ways including using tables, diagrams, graphs, models, and equations, as well as orally, in writing, and through extended discussions.

Understanding the Engineering Design Process

The engineering design process is a series of steps that engineers use to guide them as they solve problems. eCYBERMISSION recommends that engineering groups and organizations utilize this process when pursuing projects of a more technical nature. The Mission Folder questions have been augmented to seamlessly accommodate both scientific inquiry, as well as this process.



Source: <http://www.nasa.gov>

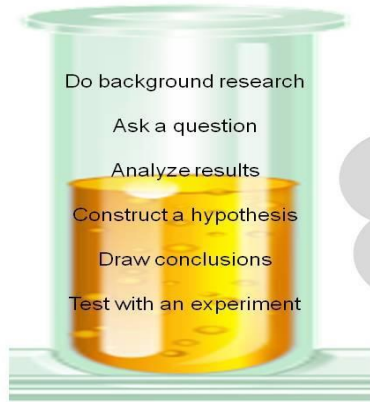
Engineers design and build all types of structures, systems and products that are important in our everyday lives. The National Aeronautics and Space Administration (NASA) recommends teams utilize the below series of steps to solve engineering-based problems:

1. **Identify the Problem:** State the challenge problem. Example: How can we design a _____ that will _____?
2. **Identify Criteria and Constraints:** Specify design requirements, or criteria.
3. **Brainstorm Possible Solutions:** Each student on the team sketches his or her own ideas as the group discusses ways to solve the problem. These sketches should be brief and use rudimentary labels to show the basic mechanics of the item.
4. **Generate Ideas:** Each student should develop two or three ideas more thoroughly. Students create new drawings that are orthographic projections and isometric drawings.
5. **Explore Possibilities:** Share and discuss the ideas among team members. Students should discuss the pros and cons of each design idea.
6. **Select an Approach:** Identify a design that best appears to solve the problem and create a statement that describes why this solution was chosen for future use. In this statement, include criteria and constraints for future reference.
7. **Build a Model or Prototype:** Construct a full-size or scale model based on the drawings.
8. **Refine the Design:** Examine and evaluate the prototype based on the criteria and constraints listed previously. Based on the criteria and constraints, the team will identify any problems and pose additional solutions.

The engineering design process is cyclical and can begin at any step, or move back and forth between steps. It is important for teams to understand that since an object or invention is never refined to perfection, this process can be continuously implemented throughout the stages of development.

eCYBERMISSION Investigative Techniques Worksheet

Step 1: Put the steps in the correct order based on what you've learned while reviewing various scientific investigative techniques:



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Step 2: Using what you've learned about the engineering design process, look at the description below. Decide which description goes with each step and write the appropriate item in each box.

- Test your solution
- Research what others have done. Discover what materials are available.
- Use your knowledge and creativity to come up with many solutions. Choose one idea and draw or make a model of it.
- Evaluate how the solution worked and think of how to improve your design.
- Make your solution.
- Describe the challenge to be solved, including limits and constraints

Source: The Works, A Hands-On Museum

