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Model-Eliciting Activities to Develop Problem-scoping Skills at Different Levels (Resource Exchange)

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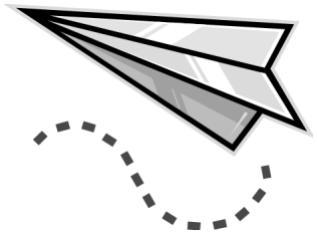
(Resource Exchange)

Target Grade Level: Various Grade Levels

EngrTEAMS

Engineering to Transform the Education of Analysis, Measurement, & Science



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Problem-Scoping/Problem Framing

Problem-scoping or Problem Framing, the process by which engineers iteratively define and refine the problem, is an important part of the engineering design process but also one that requires specific skills and habits of mind. Few activities, however, are structured to help students develop these skills. Here we share three activities that were specifically developed to emphasize the problem-scoping phase of the engineering design process: The *Paper Airplane Contest***,** the *Changing Leaves Problem***,** and the *Protecting Pelican Colonies* problem. In these activities, students are presented with a client who has a rich, but ill-defined realistic problem. Students then engage in a structured dialogue with the client, where they generate a list of questions for the client who then responds with appropriate answers. As they ask more specific and targeted questions, more important information about the problems are revealed to the students.

Model-Eliciting Activities

A quality engineering education includes conceptions of engineering design and modeling. Many times, the product from an engineering design process is a model. Model-eliciting activities (MEAs) are client driven, realistic problems, the require students to develop models as their solutions, and encourage students to engage with big ideas in engineering, science, or mathematics. Using MEAs within engineering contexts has gained favor since the early 2000's, but the problems were often posed as already defined tasks, that while open-ended in possible solutions, provided the students all of the outside information that they need to develop the model. In practice, we have found that when working on MEAs, students often misunderstand the problem or the client's needs and wants early in the problem-solving cycle. The three activities presented here are MEAs that have been modified to better scaffold the problem-defining phase of the design cycle and to support students in developing problem-scoping skills.

Activity Summaries

Paper Airplane Contest	Organizers of a local paper airplane contest ask students for help in developing a judging or scoring process for a paper airplane contest.
Changing Leaves Problem	A climatologist is tracking the relationship between climate and the size of leaves. She needs help measuring and comparing leaves based on images.
Protecting Pelican Colonies	A conservation group is trying to identify pelican colonies that are the highest priority for protection. They enlist the students to help determine the size of a colony based on maps and aerial photographs.

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Activity Descriptions

Paper Airplane Contest. The organizers of the Twin Cities Paper Airplane Rodeo are preparing for the annual paper airplane contest. Each year, participants build paper airplanes and compete for the prizes of "best floater," "most accurate," and "best overall plane." In the past the judges have determined the winners subjectively, but this year, the organizers would like to create a more objective judging system.

Students are initially presented with a flyer describing the very basic ideas and rules of the contest along with a letter from the organizers asking for the student's help. The letter provides little information other than the types of awards given, a rough description of previous judging methods, and a statement of the organizers' desire to make the judging more fair. Students then generate a list of questions which are presented to the client who responds at a level of detail commensurate with the question. Eventually students are provided with more detailed information about the rules of the contest, and they are provided with sample data on flight time, flight distance, distance from target, and angle of deviation from the target.

Students work together in teams to determine a fair way to combine some or all of the data to determine the winners of the contests. The project concludes with students sharing their scoring procedures with the client and each other.

Changing Leaves Problem*:* A climatologist is studying the way changes in the climate from year to year and over longer periods of time impact plants and animals. Specifically, she is tracking the way the size of the leaves on a tree change from year to year. The scientist has collected images of leaves from the same trees over several years. The students are asked to develop a method to first determine the actual size of the leaves from the images, and then to develop a procedure for determining if there is a meaningful difference in the size of the leaves.

Initially, students are provided only with the scientist's goal of determining how changes in climate impact trees. Through back and forth questioning with the client (mediated by the classroom teacher), students learn more details about specifically what the scientist is trying measure, what data have been collected, and how those data were collected.

In teams, students create procedures for reliably and efficiently measuring the sizes of the leaves from the picture. Using values they get from those measurements, they then examine data from two different years to see if the leaves have changed in size. Students are encouraged to explore the data in a variety of representations. The project concludes with a class discussion about whether the data do indicate a change or not, and then students communicate their findings, procedures, and recommendations back to the client.

Protecting Pelican Colonies*:* The U.S. Fish and Wildlife service has decided to identify certain pelican colonies across the country to label as protected and to target conservation efforts. Not all colonies can be protected, so the conservationists must prioritize which colonies are most important for success of pelicans overall. One of the factors they consider in choosing colonies to protect is the size of the colony, but measuring the size can be challenging as too much human interaction can disturb the pelican nests. The U.S. Fish and Wildlife service wants help determining the sizes of the colonies.

Students are presented with an article outlining basic information about pelicans and a description of how humans are impacting pelican colonies. Students then learn that the client is working on conservation efforts to protect the pelicans and needs their help. Students generate ideas and questions for the client, and through the client's answers they learn more about their specific challenge. Eventually they are presented with an aerial photo and colony maps for two different colonies.

Students work in teams to determine a method for estimating the size of a colony based on the information provided, and they use this method to compare the two colonies presented to them. Students then share their methods with the client and their classmates.

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