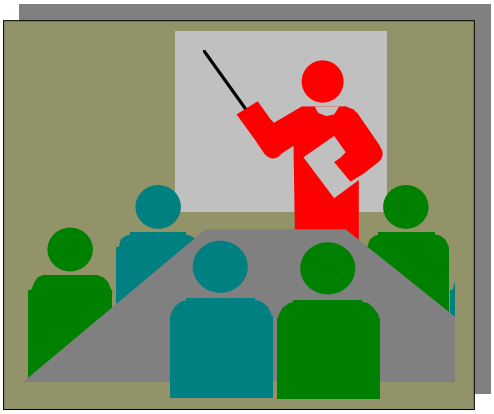
NASA's Deep Impact Mission: Decision Making

Clarifying the Issues

TEACHER GUIDE

BACKGROUND INFORMATION



In this activity, students build and present a case for a particular observation scenario that is to be used to inform and convince others.

Student groups will use the research on their chosen observation method that they collected in the last activity to prepare a presentation and defense of their scenario that takes into account the risk, benefits, and quality (meeting science objectives). The case built by each group should include a specific plan for the observation method, specific details for implementing that method, as well as risks and benefits of that method.

The various perspectives that the students read about in this section include those of members of the Deep Impact science, management, and engineering teams. Students read position statements from Dr. Karen Meech, University of Hawaii, who specializes in Earth-based observations; Brian Muirhead, project manager at the Jet Propulsion Laboratory; and John Marriott, an engineer at Ball Aerospace Technologies Corporation. As you can see from the respective work roles, these individuals represent very different priorities, but must all work together and come to an agreement in order for the mission to be successful.

The National Science Education Standards call for students to develop descriptions, explanations, predictions and models using evidence. Throughout their preparation of the presentation, students must keep in mind the difference between explanation and description; their claims must be based on evidence and logical argument. It is therefore imperative that they have established a fair knowledge of subject matter in the previous activity. In developing their presentation package, students must decide carefully what evidence to use, and what evidence or anomalous data they should prepare to defend. Likewise, they will have to give considerable thought to the manner in which they will communicate the techniques and methods they used to generate, analyze, and draw conclusions from their evidence. Mathematics is an important aspect of this process of gathering, organizing, and presenting data, and should be brought into the presentation as support wherever possible. Varying stakeholders will emerge in the next activity. There are a myriad of scientists, engineers, technicians, and public citizens who will each pose different concerns and questions. At this stage, students should begin to understand that their solutions do indeed relate to human needs, desires, and opinions. Every data collection solution being prepared will have side effects, and it is the job of the student to best balance the costs and risks of their solution with the benefits that will be recognized. They learn to be systematic and objective in this portion of their preparation, and also attempt to use probability estimates to minimize risks when compared to benefits, including any social or personal benefits that can be derived. The advancement of science due to technology becomes apparent in this activity, as does the fact that technology can be driven to higher standards by science and a quest for better and higher quality data, even under constraints. The concept of building in back-up measures, thereby reducing the risk (never eliminating it) also is considered in preparation for the presentation. Finally, students' preparations must support creativity and insight, and the recognition that people, not scoring machinery, will determine the method of collection considered most worthy for the mission.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry

Abilities Necessary to do scientific inquiry.

Develop descriptions, explanations, predictions, and models using evidence.
Think critically and logically to make the relationships between evidence and explanations.
Communicate scientific procedures and explanations.
Use mathematics in all aspects of scientific inquiry.

Science and Technology

Understandings about science and technology.

Science in Personal and Social Perspectives

Risks and benefits.

Science and technology in society.

History and Nature of Science

Science as a human endeavor.

Nature of science.

Grades 9-12

Science As Inquiry

Abilities Necessary to do scientific inquiry.

Formulate and revise explanations and models using logic and evidence.
Recognize and analyze alternative explanations and models.
Communicate and defend a scientific argument.

Science and Technology

Understandings about science and technology.

History and Nature of Science

Science as a human endeavor.

Nature of scientific knowledge.

(View a full text of the National Science Education Standards.)

LANGUAGE ARTS STANDARDS ADDRESSED

Standard: 8 Demonstrates competence in speaking and listening as tools for learning

Level III Grades 6-8

Listening and Speaking

Demonstrates competence in speaking and listening as tools for learning.
Conveys a clear main point when speaking to others and stays on the topic being discussed.
Presents simple prepared reports to the class.

Level IV Grades 9-12

Listening and Speaking

Adjusts message wording and delivery to particular audiences and for particular purposes (e.g., to defend a position, to entertain, to inform, to persuade).

Makes formal presentations to the class (e.g., includes definitions for clarity; supports main ideas using anecdotes, examples, statistics, analogies, and other evidence; uses visual aids or technology).

Responds to questions and feedback about own presentations (e.g., defends ideas, expands on a topic, uses logical arguments).

(View a full text of the McREL Compendium of Standards and Benchmarks for K-12 Education)

MATERIALS

For each student:

- Student Presentation Guide, "Defend This!"
- Completed observation Strategy Information Sheets (Deep Impact Spacecraft, Earth-based Observatories, and Earth Orbital Facilities)
- Deep Impact interview summary sheets:
  - Dr. Karen J. Meech
  - Brian Muirhead
  - John Marriott
- Four Listening Notes sheets
- Student Text, "What Goes Around Comes Around"
- Presentation materials if necessary (poster board, computer disks, etc.)

PROCEDURE

1. Explain to students that they are going to listen to three more interviews using the same process that was used in the first activity, "Capture the Issue." This time, they are going to listen to three viewpoints from members of the Deep Impact science, management, and engineering teams. Ask for three volunteers to come forward and read the interview summary sheets. Give each volunteer a different sheet and instruct him or her to read it silently. Tell them that they are going to read the sheets dramatically to the class.

2. While the volunteers are silently reading the interview sheets, distribute three Listening Notes sheets to each person in the rest of the class. You may want to review the process for using these notes from Procedure 7 in the Teacher Guide to "Capture the Issue." Once everyone is ready, a student volunteer should read the

Teaching Tip

It is difficult to assist groups for too long as an entire class. Students become acutely aware that they are preparing to meet a challenge from other groups. Arranging for sharing with these groups as well as open learning from each other can be delicate. A strategy that often works well is using a "debate scrimmage." As with any scrimmage, the agreement is to learn from each other. Two groups engage in a friendly exchange using any of a number of formats. They may choose to scrimmage early in the preparation, or later, on mutual agreement with their opposing "partner" group. It is suggested that these interactions be limited to two groups, and that groups have the choice of pairing off for a period of time. Groups that opt out of this activity may take the additional time to prepare within their own group. Groups should only be allowed one "scrimmage."

interview summary as individuals take notes. A good strategy would be for the volunteer to read the summary twice. The first time, students should listen without taking notes, the second time students can take notes.

3. Once the interview has been read a second time, distribute the interview summary sheet to the class and instruct them to include the main idea for their notes in the left-hand column. Students may work in their small groups on this part of the activity. Repeat Procedure 2 for the other interview summaries.

4. For students wanting more in-depth information about the interviews, provide the full-length interview located in the appendix.

Alternate Strategy Tip
For advanced students, consider using the full interviews located in the Appendices.

5. Once everyone has had a chance to complete their Listening Notes, ask students to respond to questions similar to the following, in their home groups:
   - Based on what you have just heard, what new questions do you have?
   - In what ways have the interviews changed your group's thoughts about the scenario you have constructed? (You may spend time addressing these changes in your group scenario.)

6. Explain to students that they are now going to use the information they compiled through their research in the last activity in order to prepare their collected ideas on how to optimize data return for science team and public review. Tell them they will need to prepare a presentation that meets a multitude of requirements, and be prepared to defend their views as a result of this preparation.

Teaching Tip
During final preparation of the presentation, an excellent opportunity is presented for students to learn to use presentation software. If only one computer is available, use a rotation schedule of student group use of the computer throughout the preparation phase. If plentiful, a computer may be assigned to each group for development of presentation slides, along with any other needs they may have. Microsoft PowerPoint, Hyperstudio, and Astound are all excellent choices. Students may even choose to develop a browser-based presentation, the construction of which would not greatly differ from that of a Web page. Note that if computers are used, you will need to provide a computer projector for the actual presentations in the next activity, or at a minimum provide students the means to print their slides on transparencies for use with an overhead projector. Take care not to engage students in preparation of materials that they can not properly use in the next activity.

7. Allow students to move into their groups and distribute the student presentation guide and a copy of the meeting rules. It is important that all students understand that they must adhere to the meeting rules. These rules may even be posted in the room and used throughout the next activity, avoiding the need to distribute copies. Ask each group to first clearly state its scenario "case," including the description, primary subject matter evidence in support of that, and the "argument" or primary points they would like to make in support. Discuss the nature of these broadly focused ideas with students. The "description" (Item 1 on the Student Presentation Guide) should be thorough, yet easily understandable by those not completely informed about the specific content. The "evidence" (Item 2 on the Student Presentation Guide) should include that which is problematic as well as that which strengthens their group's claims. The "arguments" (Item 3 on the Student Presentation Guide) refers to the group's strategy for using the evidence in their presentation to convince the various stakeholders.

8. Ask students to proceed with the remainder of their preparations, and provide assistance to each group as needed. Selecting appropriate methods for presenting their arguments (Item 4 on the Student Presentation Guide) and expressing a positive balance of benefit with risk will prove to be a mathematical challenge for many students. Be prepared to stop and provide large or small group

instruction on basic probability calculations, or even computation and graphing. It is part of the value of the learning in this phase of the cycle, and should not be discarded. Student preparation for persuading various stakeholders (item 5 on the guide) will likely be quite enjoyable and valuable to students of all ages, especially if they are asked to role-play within their group. They could assume the role of one of the mission team members, a member of the public, or other role, and from that viewpoint attempt to find problems or holes in their own group's ideas. It is often effective to allow students to create their own characters in order to engage in the same effort to make their partners "defend this." Many students will have a very difficult time with understanding the mutual positive impact that can or will be recognized by their chosen data collection method. This is typically due, however, to a simple lack of understanding of the concept, and most problems can be remedied by providing each with the Student Text "What Goes Around Comes Around."

RESOURCE

National Research Council. (2000). *Inquiry and the National Science Education Standards.* National Academy Press. Washington, D.C.