ANSWER THE BIG QUESTION INTRODUCTION

Answer the *Big Question*

How Do Scientists Work Together to Solve Problems?

◀ *1 class period**

Overview

Students watch a video in which real-life designers meet a design challenge by researching the variables involved, identifying criteria and constraints, trying various ideas, and collaborating to arrive at a final design. Students compare what the designers do in the video to what they did in class. Then, discussing the *Stop and Think* questions and writing answers to the *Reflect* questions, they use what they learned through their projects and the video to answer the *Big Question* of the Unit: *How do scientists work together to solve problems?*

Materials

1	per class	DVD player and television
1	per class	IDEO Video, "Deep Dive"

Activity Setup and Preparation

Have a DVD player and television ready to show the video before class.

Preview the video before showing to the class.

Homework Options

- **Science Process:** How would the design process have been different if you had skipped the experiments at the beginning? *(Students' answers should reflect a realistic assessment of how the results of the experiments were useful.)*

*A class period is considered to be one 40 to 50 minute class.

1 class period ▶

Answer the *Big Question*

How Do Scientists Work Together to Solve Problems?

5 min.

Remind students of the Unit question and how they have been working together to solve challenges (i.e., Build a Boat Challenge, the Lava-Flow Challenge, and the Basketball-Court Challenge).

ANSWER THE BIG QUESTION IMPLEMENTATION

Answer the Big Question

Top: *A trio of designers reviews a proposed concept framework together.* ***Middle:*** *A project team compares a series of models for a skate park layout.* ***Bottom:*** *The informal atmosphere of a lounge area acts as a backdrop to a group brainstorm.*

How Do Scientists Work Together to Solve Problems?

You began this Unit with the question: *How do scientists work together to solve problems?* You addressed several small challenges. As you worked on those challenges, you learned about how scientists solve problems. You will now watch a video about real-life designers. You will see the people in the video engaging in activities very much like what you have been doing. Then you will think about all the different activities and reasoning you have done during this Unit. Lastly, you will write about what you have learned about doing science and being a scientist.

Watch

IDEO Video

The video you will watch follows a group of designers at IDEO. IDEO is an innovation and design company. In the video, IDEO designers face the challenge of designing and building a new kind of shopping cart. These designers are doing many of the same things that you did. They also use other practices that you did not use. As you watch the video, record the interesting things you see.

META NOTE

If you remember a specific instance(s) of groups solving a problem by working together this would be a good example to discuss with the class.

Engage

Initiate a discussion of what the class has learned in *Digging In* about working together to solving problems. Students might say that they have learned to share results, to work in small groups to develop ideas or get data and then to get feedback, and to use standard procedures. Connect this with any *Solutions Briefings* you conducted during the *Basketball-Court Challenge* since they will be students' most recent experiences of presenting to get advice from the class. Ask what some real-world applications of these problem-solving strategies might be.

TEACHER TALK

"What are some of the problems you solved to control erosion? How about in the boat challenge? What are some of the things the class did that helped make it easier to solve those problems? What are some real-world challenges where you could use these skills?"

Get Going

Have students write letters with recommendations to the school board. Emphasize that the recommendations should be clear and specific, supported by evidence and science knowledge.

Let students know that they will watch a video about a design team that solves these kinds of problems every day. In this video the team is working on the design of a shopping cart. Go over the *Stop and Think* questions with the class before they watch the video so that they know what to look for in the video. Then show the video to the class.

The video is just over 20 minutes. Students should note relevant information to the *Stop and Think* questions while watching the video.

Watch

25 min.

Show the IDEO video to the class.

NOTES

Stop and Think

15 min.

Have students answer the Stop and Think *questions after watching the IDEO video.*

After watching the video, answer the questions on the next page. You might want to look at them before you watch the video. Answering these questions should help you answer the *Big Question* of this Unit: *How do scientists work together to solve problems?*

Stop and Think

1. List the criteria and constraints that the design team agreed upon. Which criteria and constraints did the team meet? In your opinion, what other criteria and constraints were not included in the team's discussion?
2. Why did the team split into smaller groups? What did the team hope to accomplish by doing this?
3. What types of investigations did you see the teams doing? What information were the teams trying to collect? Discuss how the information they collected helped the team design a better shopping cart.
4. Why do you think team members' ideas were not being criticized during the initial stages of design?
5. Give at least three examples from the video of how this group of people kept themselves on track to reach their goal on time. (How did they keep the project moving along?)
6. Analyze the teams' final product. List three advantages and three disadvantages you see in the new shopping cart.
7. Compare the practices you saw in the video to the practices you used in the classroom. How are they different? How are they the same?
8. Give examples from the video of collaboration and design practices you did not use in the classroom.
9. List two aspects of the IDEO work environment you liked. List two aspects you did not like.

△ Guide

After the class has seen the video, have students write their answers to the *Stop and Think* questions and then meet with their groups to come up with the best answers.

Once groups have had time to write their answers, discuss them with the class. You can use the following points to guide the discussion.

1. Students should be able to identify most of the criteria and constraints discussed in the video during the interview stage and the initial design discussion called *Dive In*. The criteria and constraints mentioned in the video are: Constraint—the design must be constructible and it must cost about the same as a traditional

shopping cart. Constraints—it must be safe for children, it should discourage theft, carts must nest, groceries should be easy to find, it shouldn't be likely to coast away in the wind.

2. Students should be able to pick out the criteria and constraints met by the final design. The design team met the criteria for child safety, discouraging theft, nesting carts, easy to find groceries, not likely to move in the wind, and easy to move (wheels turned in all directions). They also met the constraint of costing the same as a traditional shopping cart.
3. Students should come up with other criteria or constraints. These will most likely come from their own experiences with shopping carts. Other possible criteria and constraints not mentioned: They should be durable in all weather conditions; they should not require much cleaning; and that they should have high capacity.
4. Students should demonstrate understanding that smaller groups can obtain background information faster and can focus on one aspect of the larger challenge. This keeps the designers focused and allows each group to optimize just one idea and tends to be a more efficient use of time. The design team determined four focus areas to work on (safety, ease of checkout, ease of finding groceries in cart, ease of shopping) and decided that a team should investigate and design a cart with just that feature in mind. After, they could pull the design features together into a single cart.
5. Students should note that the first investigation the designers did was researching the problem.
6. Student responses should describe how design teams investigated what problems shopping carts had and how people used them: the team members observed and interviewed shoppers using shopping carts, and they interviewed store employees who worked with the shopping carts about what kinds of issues they had.
7. Student responses should include how they used the information obtained to plan designs addressing the problems they heard about.
8. Student responses may include how ideas that don't seem to work may become useful when combined with other ideas, how ideas that don't work may lead to ideas that do work, and how critiquing rather than criticizing ideas encourages open brainstorming.
9. Examples might include: the team broke into small groups that each focused one of the issues; team leaders occasionally orchestrated the efforts of the group; and the group voted on ideas to work with, narrowing its focus.

10. Some advantages students might point out are: since it has no components with a lot of surface area (once the baskets are removed), it is unlikely to coast away in the wind; it allows you to leave the cart somewhere and take only the basket with you as you shop; it has a safety seat for children with a work area, the wheels move in all directions. Some disadvantages students might point out are: the plastic baskets may not be durable and may need to be replaced often, and the storage and cleaning of all the components may be tedious and time consuming, the cart may support paper bags to be hung from the hooks when leaving the store.

11. Some of the similarities students may describe are: the class and the design team both did a lot of brainstorming; they both thought about what the criteria and constraints were; they both shared mockups after smaller groups had tackled individual design problems; they both built on everyone's ideas to get the best solution. Some of the differences students may describe are: IDEO started out with the whole group brainstorming general ideas, while the class only brainstormed as a group when it was identifying criteria and constraints and when groups presented their work to the class for feedback.

12. Student responses may include: IDEO's team posted ideas on the walls and then voted on them.

13. Look for things students liked that might be useful principles. Look for things students did not like that might be things that could be changed or that were not essential to the design process.

14. Students may point out: team members had to refrain from criticizing one another's ideas; team members had to stay focused—one conversation at a time; and team members had to collaborate and build on each other's ideas.

15. Possible ways of relating these to working with a group in the classroom are: brainstorming in a classroom was most effective when students proposed ideas without fear of criticism; when groups focused on investigating one variable, it kept their conversations focused; and the presentations the class gave—including Investigation Expos and Solution Showcases—allowed groups to build on one another's ideas.

10. The IDEO workers have to take on extra responsibilities to maintain their fun, yet productive, work environment. Identify and discuss at least three of these responsibilities.

11. Relate the responsibilities you identified to working with a group in the classroom. Justify your choices using evidence.

Reflect

The following questions review the concepts you learned in this Unit. Your goal was to understand how scientists solve problems. You should start thinking about yourself as a student scientist. The things you are learning about how scientists solve problems will help you solve problems in the classroom and outside of school, too.

Write a brief answer to each question. Use examples from class to justify your answers. Be prepared to discuss your answers in class.

1. *Teamwork* – Scientists and designers often work in teams. Think about your teamwork. Record the ways you helped your team during this Unit. What things made working together difficult? What did you learn about working as a team?
2. *Learning from other groups* – What did you learn from other groups? What did you help other groups learn? What does it take to learn from another group or help another group learn? How can you make Plan and Solution Briefings work better?
3. *Informed decision-making* – What is an informed decision? What kinds of informed decisions did you have to make recently? What do you know now about making informed decisions that you did not know before this Unit? What role do results from investigations play in making informed decisions? Provide an example of using results from an investigation to make a decision during this Unit.
4. *Iteration* – Simply trying again is not enough to get to a better solution or understanding. What else do you need to do to be successful? What happens if your design does not work well enough the second time? What if a procedure you are running does not work well enough the second time?

Reflect

20 min.

Lead students in a discussion that reflects on the main goals of this Unit and answers the Big Question *– how do scientists work together to solve problems?*

△ Guide and Assess

Use the *Reflect* questions to assess students' understanding of the *Basketball-Court Challenge*. Have students write their answers to the *Reflect* questions, and then lead a discussion of students' responses. Use the points below to guide the discussion and assess students' answers.

1. Student responses should include the contribution of ideas, whether they were used in the end or not, and choices that students made. Students might describe a difficulty as when they have opposing ideas, when they don't understand a group member's idea, or when they misunderstand each other's ideas. Students may mention that they learned the usefulness of brainstorming with their group, that even idea is that don't work have value, and building on each other's ideas.

2. Make sure student responses contain the idea of building on each other's ideas and the usefulness of getting advice from the class, particularly in *Plan and Solution Briefings*. Students should also describe their ideas on how to improve these briefings. Remind students of the importance of giving credit if they do not bring it up. Student may describe how using information from each other's experiments helped to save time so they didn't have to investigate everything on their own.
3. Students should describe an informed decision as one being based on evidence from experiments and science knowledge. In making recent informed decisions students should describe decisions they made in the challenges *(Basketball-Court Challenge, Lava-Flow Challenge, and Build a Boat Challenge)* to improve the design. Students used the results of their own experiments and science knowledge in the *Basketball-Court Challenge*.
4. Students should describe how using the iterative process helped them to improve their designs. They should mention the process changing one small thing in their design during each iteration as the most effective way of using iteration. If they change many things at once, they won't know which of those things made a difference. Similarly, students should realize that, even if their design doesn't work on the second try, they should not scrap it, but instead they should keep modifying it in small ways.
5. Students should know that a criterion is something that must be achieved to satisfy the requirements of the challenge. Students may mention constraints as well. If they do not, bring up the constraints as being the limitations, such as the materials.
6. Students' answers should say something about fair tests being things that are tested under the same conditions (so procedures must be consistent, only the manipulated and responding variables are allowed to change and all other variables must be held constant), and a test that provides an answer to the investigative question being asked.
7. Students should understand that when they are investigating something, they cannot determine what causes a change if more than one thing is varying. That is why they should only intentionally change one variable, measure how the responding variable changes, and keep all other variables constant if possible. If they cannot keep other variables constant then they should make sure their change is insignificant to their results. Students should describe examples of from the boat challenge and the *Basketball-Court Challenge*.

Advise the School Board

5. *Achieving criteria* – What is a criterion? How do you know which criteria are important? What if you cannot achieve all of them? How did you generate criteria? On which challenges were you able to achieve the whole set of criteria? How did you decide which ones to achieve?

6. *Running experiments and controlling variables* – What does it mean to do a fair test? What is hard about doing a fair test? What happens if you do not control important variables? Some variables are more important to control than others. Why? Use examples from class to illustrate. What did you learn about running experiments successfully that you did not know before? Use examples from class to illustrate your answer.

7. *Modeling and Simulation* – Sometimes a process in the world is too small or too large or too complicated to examine. When scientists need to study the process anyway, they often create models and then run simulations on the models. What modeling did you do in this Unit? You used modeling for at least two purposes. What purposes did you use modeling for in this Unit? Simulation means running a model. What kinds of simulation did you do? Modeling and simulation are useful only if the model is similar to the real world in important ways. How did you make sure your models were similar enough to the real world for you to be able to learn from them? How did you make sure you were simulating rainfall in a way that was similar enough to the way it happens in the real world?

8. *Using cases to reason* – Scientists and engineers often have to solve problems that others have confronted before. When scientists and engineers work to solve a problem, they may write up their experience as a case study for others to learn from. They will even write up the case study if their solution did not work. This way others can learn what not to do to solve the problem. You did that as well. What are the benefits of using case studies to help you solve a problem?

DIG 121

DIGGING IN

8. Students should discuss ways that they built on the ideas and solutions of others, and the benefits. They should describe how building on each other's ideas helps to achieve a better solution, and it requires students to be attentive to other students as they present their ideas in class and aware of the goals. Students should include connections of what they did during any of the challenges of this Unit.

Then, ask students what the answer is to the *Big Question, How do scientists work together to solve problems?*

◇ Evaluate

Students' responses should include all eight of the items listed: Teamwork; Learning from other groups; Informed decision-making; Iteration; Achieving criteria; Running Experiments; Controlling variables; Using cases to reason.

Teacher Reflection Questions

- What lessons from the *Basketball-Court Challenge* did students apply to interpreting what the IDEO design team did?
- How did you assess students' participation in the *Stop and Think* discussion? Is there anything you could do differently next time?
- How did you engage students in watching the video closely and actively, rather than passively?

NOTES