

SECTION 3.10 INTRODUCTION

3.10 Build and Test***Build and Test Your Basketball-Court Solution***◀ $1\frac{1}{2}$ class periods***Overview**

Students build their basketball-court design solutions, test them, and revise them based on the results of their tests. Using the same materials they used for their simulations, students construct a model of the land, the basketball court, and their erosion control method(s) based on their design plans. They test their design and revise the solutions, and continue testing and revising as necessary, using the same procedure to test each time. Then they share their designs with the class, as well as the different design ideas they tried and why they chose the one they did.

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

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.	Students work with their groups to build and revise their solutions and then share them with the class.
Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others, consider what they did, why they did it, and what they want to do next.	Students record the revisions they make to their designs.
Erosion is the process of soil and other particles being displaced by water, waves, wind, and gravity.	Students revise their solutions as necessary to keep the soil at the basketball-court site from being eroded.



Cautions
Watch out
for spills.

Materials

1 per group	plastic bins (stream table)
1 per group	hose for the stream table, and tubing (such as straws) for drain pipes
1 per class	tape for covering the hole in the stream table
1 bin per group	native soil
1 bin per class	Spanish moss
1 bin per class	slate chips
1 bin per class	gravel
1 bin per class	potting soil
1 bin per class	sand
1 per group	spray bottle
1 per group	drain bucket
1 per student	<i>Create Your Explanation</i> page
4 per student	<i>Testing My Design</i> page
1 per class	class <i>Project Board</i>
1 per class (optional)	camera
some per class (optional)	fans (these could be electric or even made out of paper so students can simulate wind)

Activity Setup and Preparation

Consider bringing digital cameras to class so that students can photograph the design ideas they test.

Before class begins, organize materials and equipment to allow students to expeditiously run their investigations. Prepare containers of soil to distribute to groups. Also, students may need to drain water and rebuild the slope after each test.

Homework Options

Reflection

- **Science Content:** Did any groups' final designs surprise you? What were some of the differences between your design and your classmates' designs? Which do you think would be most effective at the actual basketball-court site? (*Students should recognize any major differences between their final designs and other groups' final designs. They should evaluate, based on what they know about erosion, which designs would probably work best.*)

SECTION 3.10 IMPLEMENTATION

◀ 1½ class periods*

3.10 Build and Test***Build and Test Your Basketball-Court Solution***

You planned your best design based on evidence you have available. You presented it to others. You received advice from your classmates. You might have revised your plan based on what your classmates suggested. You are now ready to test your erosion-control solution. You will test it by building a model and then simulating rainfall on the model to see how well it prevents the hill from eroding. You hope to have the erosion-control solution that works the best. If you do, the school board will accept the donated land, the basketball court will be built, and your solution will be implemented!

Build Your Basketball-Court Solution

Work with your group to model and test your solution. You will have the opportunity to revise and test your model two or three times.

After you complete your second or third iteration, the class will hold a demonstration and competition. Each group will demonstrate their basketball court solution in front of the class. Each group will also present to the class the changes they made in their design since the *Plan Briefing*. They will explain why they made those changes.

When you recommend an erosion-control method to the school board, you will need to tell them not only how to design the erosion-control method, but why you think that design is the best one. On the next pages are some hints for you about how to manage iteration to design your best solution for the basketball court.



DIG 109

DIGGING IN

3.10 Build and Test***Build and Test Your Basketball-Court Solution***

5 min.

Introduce students to the section.

Engage

Motivate the students to build their best design and let them know they may be revising their designs.

TEACHER TALK

“You’ve got a design plan, now you will be able to build it and test it—and you’ll be able to revise it too. Remember that your goal is to have the erosion-control solution that works best so that the school board will accept the donated land and build a basketball court on it.”

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

Build Your Basketball-Court Solution

15 min.

Have students build and test their basketball-court solution.

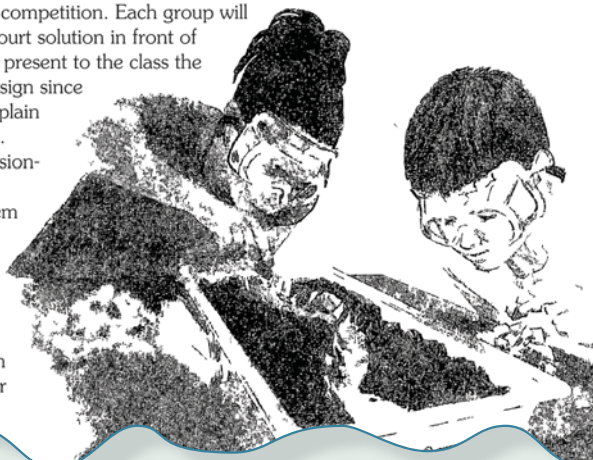
the base, the outfit, and your s... implemented.

Build Your Basketball-Court Solution

Work with your group to model and test your solution. You will have the opportunity to revise and test your model two or three times.

After you complete your second or third iteration, the class will hold a demonstration and competition. Each group will demonstrate their basketball court solution in front of the class. Each group will also present to the class the changes they made in their design since the *Plan Briefing*. They will explain why they made those changes.

When you recommend an erosion-control method to the school board, you will need to tell them not only how to design the erosion-control method, but why you think that design is the best one. On the next pages are some hints for you about how to manage iteration to design your best solution for the basketball court.



△ Guide

Let students know that they will now build and test their basketball-court solutions. Emphasize that they should not begin testing their design until after you have given them your approval to test it.

◇ Get Going

Let students know how long they have to build their designs, and then get students started. You should only have to get them started building their designs once.

◇ Get Going

Have students test the integrity of their models by saturating the soil with water and then simulating light and heavy rain. Their model should show a realistic level of erosion. If they have a landslide after a light misting, or if they have no erosion even after dumping water on the model, then they will need to adjust it.

◇ Evaluate

Before groups test their design, visit each group and make sure their model is O.K. Test the integrity of the model by simulating soft rain (spraying from a spray bottle on the model). Make sure you discuss with them the next segment before they begin testing.



Test Your Basketball-Court Solution

Below are some suggestions for testing your designs. You can use a page similar to the one shown to record your work.

Testing Your Designs

In experiments, it is important to run several trials. Then you can be sure your results are consistent. The same is true in testing a design. Each time you test a design, make sure to run enough trials. Choose the number of trials that will allow you to see how it performs. Follow the same procedure each time you test it. Otherwise, you will not know if the design is causing the effects you see or if something you did not control in your procedure is responsible for your results.

Recording Your Work

As you test and revise your design, it will be important to record the results of your tests. You will also need to record the changes you are making. You should record why you are making those changes. This is for several reasons:

- Sometimes, what seems like a mistaken approach turns out to work better when some other part of the design is changed.
- You may need to remember what you did and did not test.
- You can use your earlier designs to help teach others.
- Study your earlier designs. You can learn how your mistakes and successes contributed to your science understanding.
- You can save time by copying the working part of a design directly. You do not have to rewrite them each time.

You will use *Testing My Design* pages similar to the one shown to record your results, changes, and the reasons for changes. Use one page for each iteration.

Testing My Design	
Name: _____	Date: _____
Each time you build and test a design idea or model, you need to test it in a fair way and record the results of that test. Use this sheet to help record your various design ideas and the result of each design.	
Sketch your design. The sketch should help others clearly understand what you are modeling and how it is similar to the real-world situations it models. Draw more than one sketch if you need to.	What is the key idea you are investigating in this simulation?
	How are you running your simulation? How are you making sure you are simulating the real world?
What happened when you ran your simulation? How effective was your design at accomplishing its task? Include measurements and sketches as needed.	What have you learned from this simulation?
	What do you need to investigate to get to a better solution?

DIG 110

Project-Based Inquiry Science

Test Your Basketball-Court Solution

30 min.

Have groups iteratively test and revise their basketball-court solutions.

META NOTE

Provide guidance to each group individually rather than to the entire class as they begin this segment.

META NOTE

It is important that groups use the same procedure each time they run their test. If you see groups changing their procedure, remind the class that in addition to running multiple trials, they need to make sure that each test and each trial is run the same way.

META NOTE

As students revise their plans, remind them that it is more effective to change one small thing in the design for each iteration than to make many changes at once. This allows students to isolate specific things that work or don't work.

△ Guide

After you have given groups the O.K. to test their designs, briefly discuss the importance of test procedures with the group. Emphasize that it will be important to test each design the same way as they did the previous design. It is also important to run multiple trials for each design. Each group should decide on a procedure at the beginning, specifying the number of trials, how to run the simulation, and how to measure the results.

It will also be important to record the results of each test and all the changes made. Each group should record their results for every iteration on a *Testing My Design* page.

As students are working on their designs, you may choose to have them briefly present to the class if they are very successful or having difficulties. By showing the class the designs they are working on and how they have modified their plans allows the rest of the class to give or receive advice.

As groups are testing their designs, you can ask them what ideas they have tried out. If any groups seem stuck on a design and don't think they can improve it, you might ask them what they know about alternative designs. Would removing a feature of their design make it work better or worse? Or would adjusting a feature make it work better?

**Communicate
Your Design:
Solution
Briefing**

20 min.

Have students present their Solution Briefings to the class.

△ Guide

Once students have finished iteratively building and testing their designs, let them know that they will next briefly present their design to the class.

Remind students of the information a *Solution Briefing* should convey: the original design plan, the history of the group's revisions, the way the group used the recommendations of the class, and the final design. Emphasize that it should also detail the changes the group made in each iteration and the reasons for the changes. Let students know how long they will have for their *Solution Briefings*, and give them a few minutes to prepare their presentations.

Then, have each group briefly present their design solution. As each group presents, encourage students to ask questions and model the kinds of questions students should be asking. These should be about what techniques groups tried, what criteria the designs achieve, how the constraints were or were not accounted for in the design, and whether there are any problems with the design.

NOTES

.....

.....

.....

.....

.....

.....

3.10 Build and Test

Iteration

Remember that iteration is a process of making something better over time. That something may be a product, a process, or an understanding. Scientists and student scientists iteratively understand new concepts better over time. Scientists iteratively make investigative procedures better over time (as you did in the *Lava Flow* activity).

Designers iteratively make designs better over time. Each time they test a design, they might find ways to improve it. That is what you are doing now. Sometimes a design does not work as well as the designer expected. When that happens, the designer tries to understand why it is not working as well as expected and makes changes based on that analysis. If your design doesn't work as well as you wanted it to, your first feeling may be to throw away those failed plans and begin again. Do not! If you began with a design based on evidence and science, then your solution will probably work well with some changes. Designers only throw away designs and begin again if the problems are so big that it would be easier or less expensive to begin again.

You saw the power of iteration earlier in this Unit. In the *Build a Boat Challenge*, you improved the design of your boat. You built the boat and tested it. You identified weaknesses and improved your design. Now, with your erosion-control method, you will again have the opportunity to iteratively enhance your design.

Usually, the best way to iterate is to make one revision at a time. If you make and test one change at a time, then you will know the effect of that change.

You can do as many iterations of your erosion-control design as you have time for. However, remember that it is important to run each trial the same for every design. For example, you must pour the same amount of water onto the model in the same way for every trial. And remember that you need to pour the water to simulate real-world rainfall as well as possible.

Communicate Your Design**Solution Briefing**

While you are working on iterating toward a better design, your teacher might have you present your design-in-progress to the class in a short *Solution Briefing*. You will also have a *Solution Briefing* when the time for



DIG 111

DIGGING IN

Reflect

15 min.

Have groups answer the Reflect questions and then discuss answers with the class.

testing your solutions is over. Recall that a *Solution Briefing* is very much like a *Plan Briefing*. You present your solution for others to comment on.

An important issue you will have to pay attention to when you engage in these *Solution Briefings* is time. Because you have to break down your designs at the end of each class period, each presentation will have to be quick to fit them all into one class period. When your teacher calls a *Solution Briefing*, be prepared to briefly present your progress. Describe the design you are working on. Tell the class how it is different from what you thought you were going to build. Tell them why it is different. Show them what happens when you pour rain on it. Tell them anything you are having trouble with, and ask for advice. Your group's experience may provide valuable lessons for others. If you are having trouble, a *Solution Briefing* is a chance to get help.

Remember, you can learn from attempts that did not work as well as you expected. So do not be shy about presenting what has not worked as well as you expected. You and others can learn from mistakes. Your peers can give you advice about design, construction, and testing.

Reflect

Discuss your erosion-control solution design and what you learned from the *Solution Briefing*. Answer the following questions and be prepared to discuss your answers with the class:

1. How well does your design meet the criteria and constraints of the *Basketball-Court Challenge*?
2. What changes did you make to your design to improve its ability to control erosion?
3. Describe any ideas you got from other group's designs and presentations or recommendations you used to improve your own design.
4. What changes do you think you still need to make to your design to be more successful?
5. You probably can make some new recommendations about managing erosion, this time about combining erosion-control methods with each other. What new recommendations, if any, should be added to the *Project Board*? Develop your recommendations and their supporting explanations using *Create Your Explanation* pages.

Get Going

Give groups a few minutes to answer the *Reflect* questions on their own. Then lead a class discussion of their answers. Listen for the following:

1. Students should evaluate how well their solution meets each of the criteria and constraints they identified. These should include:

Criteria: must prevent erosion at the top of the hill from covering a 28 m X 15 m basketball court at the bottom of the hill.

Constraints: the basketball court must be 5 m from the base of the hill; project must not damage houses (30 m X 10 m) that are 12 m from the court on either side; height of the hill is 10 m.

3.10 Build and Test

Update the Project Board

Based on your experiences combining erosion-control methods with each other, you have derived some new recommendations. Update the *Project Board* with any new recommendations you have and any new evidence you have collected that would help support them.

What's the Point?

You have just built and tested your basketball court model to evaluate your erosion-control solution. You have run several simulations of your solution and followed the same procedure each time. Each time, you recorded your work and revised your design if it did not work as you expected. You also recorded why you made changes to your design before each new iteration. You presented your design-in-progress to the class in a *Solution Briefing*, asked for advice, and listened to the presentations of others. Based on your experiences combining erosion-control methods, you developed new recommendations and supporting explanations and added them to the *Project Board*. Modeling and simulation is used to test solutions when it would be too dangerous or too expensive to test solutions in the real world. It is always important to be able to predict how a solution will perform before building it. It is also possible to learn how to make a solution better by modeling it.



DIG 113

DIGGING IN

2. Students should have documented the changes they made in their *Testing My Design* pages.
3. Students should recognize the ways they used ideas that came from class discussions.
4. Students should honestly evaluate the ways in which their solutions need more work.
5. Students should have ideas for new recommendations. Use these to guide students to begin thinking about how to update the *Project Board*.

Update the Project Board

5 min.

Have the class update their Project Board.

Update the Project Board

Based on your experiences combining erosion-control methods with each other, you have derived some new recommendations. Update the *Project Board* with any new recommendations you have and any new evidence you have collected that would help support them.

What's the Point?

You have just built and tested your basketball court model to evaluate your erosion-control solution. You have run several simulations of your solution and followed the same procedure each time. Each time, you recorded your work and revised your design if it did not work as you expected. You also recorded why you made changes to your design before each new iteration. You presented your design-in-progress to the class in a *Solution Briefing*, asked for advice, and listened to the presentations of others. Based on your experiences combining erosion-control methods, you developed new recommendations and supporting explanations and added them to the *Project Board*. Modeling and simulation is used to test solutions when it would be too dangerous or too expensive to test solutions in the real world. It is always important to be able to predict how a solution will perform before building it. It is also possible to learn how to make a solution better by modeling it.



△ Guide

Ask the class what new recommendations they have to add to the class *Project Board*, and update the *Project Board* as students give you information.

△ Guide

If there is time, review the importance of iteration, sharing ideas, and models.

What's the Point?

0 to 5 min.

NOTES

.....

.....

.....

.....

.....

.....

Assessment Options

Targeted Concepts, Skills, and Nature of Science	How do I know if students got it?
<p>Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.</p>	<p>ASK: How did you use things you learned from other groups as you revised your solution?</p> <p>LISTEN: Students should have used things they learned from other students' simulations to guide their design decisions.</p>
<p>Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others, consider what they did, why they did it, and what they want to do next.</p>	<p>ASK: What parts of your investigation should you record?</p> <p>LISTEN: Students should indicate that the results and the changes in procedure are important to record.</p>
<p>Erosion is the process of soil and other particles being displaced by water, waves, wind, and gravity.</p>	<p>ASK: What effects of erosion were hardest to control?</p> <p>LISTEN: Groups should use their observations to describe an effect of erosion that they had trouble controlling.</p>
<p>Scientists use models to simulate processes that happen too fast, too slow, on a scale that cannot be observed directly (either too small or too large), or that are too dangerous.</p>	<p>ASK: What questions were you able to answer using a simulation that you would not have been able to answer otherwise?</p> <p>LISTEN: Students would not have been able to test which combination of erosion-control methods would be effective.</p>

Teacher Reflection Questions

- Did students apply lessons from the previous *Learning Sets* to their use of iteration? For instance, did they make small changes for each iteration?
- How did you assess how students were giving and receiving feedback and building on each other's ideas? What indicators could look for next time?
- How did you keep the class focused as different groups were presenting their designs? What ideas do you have for next time?