mystery science

Lesson: “How do you build a city out of mud?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hey, it's Jay from the Mystery Science team! This is Sky City. Sky City stands on a clifftop in the middle of the New Mexico desert. This city belongs to the Acoma Pueblo people who first built it hundreds and hundreds of years ago and still care for it today. One of my favorite things about Sky City is how it's made. The buildings you see here are mostly built with the same material: dried mud. In this area today, people often call the mud mixture used to make these buildings by a Spanish name: adobe. Depending on where you live, you may have seen lots of buildings made of adobe already, but if you haven't seen buildings like this before, it may surprise you to learn that a whole city could be made out of mud. On its own, mud is pretty simple. Mud is dirt, or what scientists call soil, combined with water. Since lots of places have soil and lots of places have water, mud is common in many different areas. You've probably experienced mud yourself. Maybe you've splashed in a mud puddle on a rainy day. Maybe you've even gotten really messy playing in mud, like these kids did on Mud Day at their local park. But what gave people the idea to use something so mucky and squishy and ordinary to build something like Sky City, which is so big and solid and impressive? Long ago, before planes and cars and trains made it easier to move things from place to place, people often had to use the things they had nearby to build buildings. Take a look at these pictures. What do you see in these places that you could use to build a house?

EXPLORATION VIDEO 2

You see all the trees in this picture? If you chop those trees down, you can make them into logs. Perfect for building a log cabin. Or see all those rocks? Piled together, those stones can make a stone cottage. When the Acoma people settled in the place that would someday become Sky City, they knew the nearest forest was miles away. But there was a lot of soil, so they used that soil to make their homes out of mud. Even if you've never built a full-sized house before, you probably have some experience building that can help you think about this. If you've been to a beach or played in a sandbox, maybe you've built with sand to make a sandcastle. If you've spent time somewhere cold, maybe you've built a snowman out of snow, or maybe you've built one of these—a pillow fort: a hideout made from pillows and couch cushions and blankets. When you build a pillow fort or a sandcastle or a snowman, in a way you're doing what people did to build homes long ago. You're using the things you have around you to build. Still, just because something is available, that doesn't necessarily mean it's good to build a house or a city with. So what does make something good for building? How do you know if something is good to build with or bad to build with?

EXPLORATION VIDEO 3

Now, I don't know how you answered, but when I think about what makes something good for building, I think about the words I'd use to describe things I've built with before. Let's take a pillow fort, for example. Some things about pillows are great for building. For one, because they're so bouncy and springy, pillows are hard to break. Pillows are usually light and easy to pick up, and easy to stack on top of each other to build a wall. The things you notice about pillows, that they're soft, light, and squishy, are all properties of pillows. Every material, from

pillows to rocks to breakfast cereal, has properties. Properties are the things you can see, feel, hear, smell, or measure that make a material unique. So if pillows have so many great properties, how come we aren't all living inside a giant, soft pillow fort? I mean, that'd be awesome. If your house was made of piles of pillows, you wouldn't even need a bed. You could just lie down on the soft pillowy ground anywhere. What do you think? Would you want to live in a house made entirely of pillows?

EXPLORATION VIDEO 4

As cozy as it might be, maybe you can think of some reasons why a whole building made of pillows might not be such a good idea. Like, check out the enormous pillow fort this family built. Looks cool, right? But if you leaned against that wall of pillows, it would fall and turn into a big pile of pillows on the ground, like this. A house made of pillows would be soft, but it wouldn't be very strong. A pile of pillows might stand up for a while, but if a big wind blew, it would all come tumbling down. And think about what would happen if it rained or snowed on your house made of pillows. The house would probably soak up all that water, and that would make your house soggy for a long time. When a pillow gets soaked with water, its properties change. It might become heavy instead of light, squishy instead of springy. A building usually needs to be able to last for years and years and stand up to weather like heat, wind, and rain without changing too much. A house made of pillows can't do that. But what about a house made of mud? Well, just look at Sky City. With help from the people of Acoma, these adobe buildings have survived for hundreds of years. The mud mixtures use to build Sky City have many properties that are good for building. Take a look. This is wet mud that will become part of an adobe building. And this is that same mud dried out in the sun. What changes do you notice? How is the wet mud different from the dried mud?

EXPLORATION VIDEO 5

As you know, mud is a mixture of soil and water. When mud has lots of water in it, it's soft and squishy. This makes it easy for builders to form adobe into exactly the shape they want. But when adobe dries out in the sun, its properties change. It becomes solid and strong. These properties help a mud building stay standing for a long time and stand up to weather without falling apart. Now I don't know about you, but whenever I hear about something that's easy to make and good to build with, I want to try it myself. Could you use the mud near you, like mud from your local park, to build a house? It's easy to think that mud is the same all around the world, but mud can be different in different places because soil is different in different places. Different soils can look different, from rusty red soil to brownish-gray to dark black. Different soils can also feel different, from really rough and grainy textures to really soft and smooth. With so much variety, how do you know if you can build a house with the mud near you? I wonder if you have any ideas.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to explore the wonderful world of mud. The people of Acoma built their beautiful city out of mud, but could you do the same? Could you go outside and use any mud you find to build a house? That's what you'll investigate today. How is mud the same? How is it different? And which mud is the best mud to build a city with? Before we explore mud, we first need to study the soil. The colors of soil can be really different, but what about other properties? What are the other differences between soils that you can observe? To help you figure it out, you'll use what scientists call a model: a pretend version of the real thing. Today you'll have three different Mystery Soils—A, B, and C—to investigate. These pretend versions

have similar properties to the real soils. Once you examine these dry soils, you'll add water to each one of them to turn them into mud. And then you'll put each mud through three tests. Each test will tell you something important about the properties of mud, and if it's good for building, You'll use the information from these tests to figure out which mud is the winner—the best mud for building a house. We'll show you how to get started, step by step.

ACTIVITY STEP 1

Find a partner. Decide who will be the Soil Captain and who will be the Water Wizard. If you're working alone, that's okay too. You'll do both jobs. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Get your supplies. Each person needs a Mystery Mud Tester worksheet, and each pair needs three Mystery Soils, three toothpicks, a plate, and some paper towels. You'll get more supplies later.

ACTIVITY STEP 3

Before we investigate mud, we first need to examine the properties of dry soil. Examine each of your Mystery Soils closely. Here are some ways you can explore. You can compare the color of each soil. You can stir each one with a toothpick to see how each soil moves in the cup. You can even rub a tiny bit of the soil between your fingers to find out what it feels like. Take a few minutes to examine all three Mystery Soils with your partner. I'll set a timer in case that's helpful. Okay, three minutes are up. If you're ready, go to the next step.

ACTIVITY STEP 4a

Now that you've had the chance to examine all three Mystery Soils, discuss.

ACTIVITY STEP 4b

Here's what we noticed. We noticed that all three Mystery Soils have slightly different colors. We also noticed that Mystery Soil A felt gritty and rough. Soil A is a pretend version of a sandy soil. You're probably already familiar with this kind of soil. It's the kind you find at the beach or in a sandbox. On the other hand, Soil B felt really soft and smooth. Soil B is a pretend version of clay soil. The little pieces that make up this soil are very, very tiny, much smaller than sand, which makes them feel soft and smooth. But what about Soil C? We noticed that it was somewhere in the middle. Not totally rough, but not totally smooth. Soil C is a mix of sandy and clay soils, so it has properties that are in between sand and clay. Now that you've noticed differences between your Mystery Soils, go to the next step.

ACTIVITY STEP 5

When you add water to soil, it becomes mud. But different kinds of soil turn into different kinds of mud—mud with different properties. Get the rest of your supplies. You'll need a cup of water and a spoon, but don't add any water just yet. We'll walk you through how much water you should add in the next step.

ACTIVITY STEP 6

This step is a little tricky, so we suggest you just watch and listen during this entire step first so you'll know what to do. Soil Captain, make sure all the Mystery Cups are on your plate. Then,

hold one steady for your partner. Water Wizard, you'll carefully add one spoonful of water to that cup. You just need one spoonful for each cup. It's better to add too little than too much. Okay, now that you know what to do, go ahead and add one spoonful of water to each of your Mystery Cups. One spoonful for A, one spoonful for B, and one spoonful for C. Don't mix or stir the mud just yet. You'll do that in the next step.

ACTIVITY STEP 7

All right, now it's time to mix your mud. Sometimes, a dry soil can take a while to mix, so you'll work with your partner to make sure each mud is really mixed. Soil Captain, use a toothpick to stir the soil and water together in Mystery Cup A for about 10 seconds. Then hand the whole thing to your partner. Water Wizard, you'll keep stirring for another 10 seconds. After 10 seconds, go ahead and check that the water is still mixed with the soil. Once you've mixed your mud in Cup A, repeat this for Cup B and Cup C, using a clean toothpick for each one.

ACTIVITY STEP 8

It's time to test your pretend mud. Test number 1 is called the Big Clump Test. To make a mud house, you need mud that sticks together. To test each mud, try to pick it up with your toothpick. If you can pick up a big clump of mud and it stays on the toothpick, then that mud is good for building a house. If the mud falls off your toothpick, then that mud is not good for building a house. All right, go ahead and test each mud to see if any of them pass the Big Clump Test.

ACTIVITY STEP 9

In a moment, you're going to fill in number 1 on your worksheet. Remember, if mud stayed on the toothpick, that's a good thing. That mud passed the test. That's one clue that it would be

good mud for building a house. On your worksheet, you'll circle the letters of the muds that passed the test and cross out each letter for muds that failed the test. Go ahead and discuss these questions as a class, then fill in Number 1 on your worksheet.

ACTIVITY STEP 10

Before we get to test number 2, we need to get the mud out of the cups. Water Wizard, turn Cup A upside down onto your plate. Soil Captain, use a pencil to write the letter “A” on the plate, like this. This will help you keep track of the muds during the next two tests. Repeat this for the other two cups. Turn over Cup B and write “B” next to it. And finally, turn over cup C and write “C” next to it.

ACTIVITY STEP 11

To make a mud house, you need a type of mud that can be formed into a shape like a brick. It's time for test number 2, which is called the Brick Builder Test. Using your toothpicks, your spoon, or even your fingers, try to make a shape like a small ball or a brick with your mud. If the mud stays in the shape you made, then that mud is good for building a house. It passes the test. If you try to form the mud into a shape, but it falls apart, then it does not pass the test. All right, go ahead and test each mud to see if any of them pass the Brick Builder Test.

ACTIVITY STEP 12

In a moment, you're going to fill out number 2 on your worksheet. Remember, if a pretend mud can make a shape, like a brick or a ball, that's a good thing. That mud passed the test. That's a sign that it could be good mud for building real bricks for a house. On your worksheet, you'll

circle the letters of the muds that passed the test and cross out each letter for muds that failed the test. Go ahead now and discuss these questions as a class, then fill in your worksheet.

ACTIVITY STEP 13

Now it's time for the final test, test number 3. We call this the Not-Too-Sticky Test. To make a mud house, you need mud that stays together and can be formed into a shape, but you also don't want it to be too sticky. Imagine trying to build a house but the mud just keeps sticking to your hands. It would be very difficult to build with. So for this test, you'll pick up each mud and see if it sticks to your fingers. If the mud does not stick to you and easily comes off your fingers, then it passes the test. If it sticks, then it's too sticky for building a mud house; this mud fails the test. All right, go ahead and test each mud to see if any of them can pass the Not-Too-Sticky Test.

ACTIVITY STEP 14

Use a paper towel to wipe off your fingers and clean your hands.

ACTIVITY STEP 15

In a moment, you're going to fill out number 3 on your worksheet. Remember, if a mud didn't stick to your fingers, that's a good thing. That mud passed the test. On your worksheet, you'll circle the letters of the muds that passed the test and cross out the letters for muds that failed the test. Go ahead now and discuss these questions as a class, then fill out number 3 on your worksheet.

ACTIVITY STEP 16

Congratulations, you're done with your mud investigation! Discuss these questions as a class, and then watch the final videos.

WRAP-UP VIDEO 1

In today's activity, you tested three different pretend soils to see if they would be good for building a house. In the Big Clump Test, you looked at whether your model Mystery Mud stuck together. If mud can't stick together, any building made with that mud will eventually fall apart. When we tried this test, Mystery Mud A didn't clump much at all. What about in the Brick Builder Test? Remember, real adobe buildings are often made by shaping mud mixtures into bricks. So in this test, you formed each of your Mystery Muds into a brick to see if it could hold its shape. Again, Mystery Mud A didn't stick together. Maybe you could press it into a shape at first, but it quickly crumbled. Mystery Soil A is a model of sandy soil. Muds made with sandy soils aren't very sticky. They crumble very easily. You may have noticed this if you've ever built a sandcastle. The wet sand might hold together at first, but one wave of water and it falls apart. If you tried to build your house with just sandy soil, it would fall down. Mystery Soil A is out. That leaves two more muds to try, B and C. In our experiment, both Mystery Mud B and Mystery Mud C clumped together in the Big Clump Test. B and C also held their brick shape in the Brick Builder Test. Mystery Mud B did especially well on both tests. Mystery Soil B is a model of clay soil. Muds made with clay soils are sticky and they don't crumble very easily. So is clay soil the best soil to build a mud house with? Well, not so fast. Our final test was the Not-Too-Sticky Test. To make a mud house, you need mud that sticks together, but you also don't want it to be too sticky. It's hard to build with something that's constantly sticking to your fingers. On this test, the

mud made with clay soil didn't do so well. When we tried to pick up Mystery Mud B, it was really sticky and hard to get off our fingers. And it turns out there's another problem, too. When mud with a lot of clay dries out, it often forms cracks. You definitely don't want the walls or roof of your house to have cracks in it. Mystery Mud B is out. So, after all of your tests, only one soil passed all three tests: Mystery Soil C. Mystery Soil C was a model of a mix of sand and clay soils. While sandy soil A was too crumbly and clay soil B was too sticky, C had the best properties of both. It was just right. So if you want to build a house using the mud near you, you might be able to—but first, you'd have to test the soil near you to see if it has the right properties. Now, you only put your pretend soils through three tests. Each test helped you learn a little more about each soil's properties, like if the soil was sticky, strong, or easy to shape. There may be other things you want to know about soil before you build with it, too. Like, what if you want to see if your mud can stand up to extreme weather, like hot sun or rain? How could you test your muds to see how they change on a hot, dry summer day or in a big rainstorm?

WRAP-UP VIDEO 2

There are all kinds of tests you can do to learn more about a mud's properties. You could try putting it under a hot lamp to see how it changes in the heat. You could freeze it and see how it changes in the cold. You could let the mud dry out and see how its properties are different from when it was wet. Getting the right mud mixture helps make finished, dried adobe buildings stronger in the face of rain and other weather. By testing the soil, you can find out if it will make a good, strong mud mixture for building, or a crumbly, weak one, before you build with it. Still, even adobe made with just the right soil isn't totally waterproof. Buildings made of mud can get damaged by rain, snow, and ice. This is one reason why buildings made with mud survive for longer in places that have dry weather, like the deserts that surround Sky City. But Sky City isn't

the only place where you can find buildings made of mud that have stood the test of time. Like, check this out. This is the Great Mosque of Djenne in the country of Mali. It's a Muslim religious temple built out of mud. With help from the people of Djenne, this enormous building has survived for over 100 years. And here's another entire city made of mud buildings. Like Sky City, The City of Shibam in the country of Yemen has towering mud buildings, some as old as 500 years old. And building with mud is still popular today. Inspired by the long traditions of mud-building in places like Acoma and Shibam, modern builders use mud to build homes, school buildings, hotels, and more. It's kind of incredible that all these different mud structures started with something as common as soil. Soil may seem dirty and ordinary when it's on the bottom of your shoes, but the right soil can make some magnificent things. So, next time you stomp through some mud on a rainy day, imagine what kind of buildings and cities you could create with what's right under your feet. Have fun, and stay curious.