Lesson: “When you turn on the faucet, where does the water come from?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! When I was in sixth grade, something exciting happened. One day, I came home from school and my mom and dad sat me and my sisters down. They had a big announcement. They said: we're going to move. Not away from town but somewhere close by. It'll be a new house. Now, I knew exactly what they had in mind. You see, my whole life my dad had been talking about his dream to one day have a backyard with a pond in it. Now, that might sound like a strange thing to want in life. But the thing you have to understand about my dad is that he loves growing flowers and trees. He loves landscaping. And for him, a pond was like the ultimate setting for the most beautiful garden. He wanted to grow lily pads and have flowers all along the banks. And maybe even have a little fountain in the middle. He was so excited. I was excited too. I wasn't as wild about gardening as he was. For me, that was usually a chore. But the thing I got most excited about was all the possible animals I'd now get to spend my time catching. You see, my cousins lived near a pond and I remember my cousin Mikey taking me out in a little rowboat when I was younger. And I got to catch a turtle in that pond. I thought that was very cool. Maybe now I'd be able to catch things like turtles and frogs in my own pond. So I said to my parents, “I can't wait. This is going to be awesome. Where is this pond? Can we go see it now?” We got in the car and drove out to the site of the new house. When we got out of

the car, I was confused. There was no pond anywhere. I thought: Dad, are you sure you got the right place? Where's the pond? He explained, “Well, there isn't a pond here yet. We're going to make one.” Make a pond? I was surprised. I didn't know that was a thing you could do. Like, dig a hole and fill it with water? That sounds like a lot of work. Now, luckily, as my dad explained, he knew someone who owned an excavator who agreed to come out and dig the hole. But I said to my dad, “So, where are you going to get the water from? There's no hose or faucet around here or anything yet.” I knew that was how people filled up swimming pools. My dad laughed a little. “Oh, all right,” he said. “You have no idea how this works, do you? I didn't used to know either. It's okay.” I guess I had no clue. I said, “Oh, are we going to have to wait for rain to fill it up or something?” My dad shook his head no. We weren't going to do that either. Okay, well, if you weren't going to fill it with water from a hose and we're not going to wait for the rain to fill it up, then how is there going to be water in this pond? Where's the water going to come from? My dad pulled a shovel out of the trunk of the car. “Watch this,” he said. And he started to dig a little hole. When he dug the hole down to a few feet, he said, “Look in there. What do you see?” To my amazement, there was water. How is that possible? What do you think? Why did my dad hit water when he dug down?

EXPLORATION VIDEO 2

Why was there water in the hole once my dad started digging down? It turns out this is something that's true in many places, not just where we were digging. If you dig into the ground, as you're digging, at some point you might notice that the hole starts to become wet. It starts to fill with water. Now, you won't always find water right away. Sometimes you have to dig really deep down, like this man is doing. It's possible you've even seen this already for yourself. If you've ever had the chance to dig down in sand, like at the beach—say you're starting to make

a sandcastle or something—as you dig, what you can notice is that the sand becomes wet. And if you keep digging—look at this—this boy has dug down into the sand, and the hole filled with water. But whether it's a hole in sand or in dirt, where is this water coming from? How did it get underground? As you might have guessed, it has something to do with rain. Now you might know—especially if you did our earlier unit, "Work of Water"—that when it rains on hills or mountains, that water flows downhill. Some of that water forms rivers, most of which eventually flow towards the ocean. But does all rainwater flow into rivers? Well, as digging these holes reveals, apparently it doesn't. In fact, a lot of rainwater seeps into the ground and somehow stays down there, unseen. Why is that? What's going on? Well, rather than just telling you about this, let me show you. My friend Amy put together this model. It's really helpful for understanding what's going on. Amy put gravel into this plastic box, to represent the ground. Now, imagine this is me, standing on the ground. All I see and feel is dry ground. There's no water here. Now suppose I use a watering can, so that I've got water falling from above, just like rain would do in the real world. That rainwater seeps down into the ground. It disappears from sight. I don't think about it anymore. But suppose now I dig down into the ground. If I dig down, if I make a hole in the ground, I might just discover that at a certain level below the ground—look at that. There's water down there. Now I've exposed some of that underground water. And look—in this case, I made a pond. Because this is a model, we can turn it and look at it from the side, too. Watch as we dig now. Now you can see what's going on down there as I dig. When rain falls, the rainwater seeps down into the ground, because there are spaces between the little bits of rock. The ground beneath our feet very often is made of things like this. It could be gravel or sand or just rock that has tiny spaces or pores. And so even though the land on the surface might be totally dry, there may be water under the surface in the spaces between the gravel or rock. Scientists call this type of ground by a special name: an *aquifer*, from the Latin words *aqua*,

which means water, and *fer*, meaning to carry or hold. It's ground that can hold water—an aquifer. Now, my dad once described it to me as being somewhat like an underground lake. That's sort of helpful, but only as long as you're clear that it's not like a cave filled with water. An aquifer is not something you could swim in. It's just water between tiny spaces in the rock. Now you might think that rainwater would just keep seeping downwards, all the way to the center of the Earth. But at a certain depth, you get to a layer of completely solid rock that doesn't have any holes in it. In our model here, that's represented by the bottom of the box. Without any spaces for the water to flow into, water can't seep down any further. And since water is a liquid that just seeps between pores of rock, notice also that the water underground forms a straight line. In fact, it doesn't matter what the landscape above looks like. Even if there are hills on top, the water line is still straight, and the water seeps down as far as it can. So, to summarize, sometimes there is water found underground, at least where the ground has tiny holes or spaces where rain can seep downwards. We call this water-filled ground an aquifer. The pond my dad dug was basically a big hole in the backyard, where we exposed water that was already there in the ground. In other words, by digging that hole, we revealed water that was sitting in an aquifer. This is what most ponds and lakes are. This knowledge—that in some places there's water below the ground—this isn't just useful knowledge for people who want to dig their own ponds. The existence of aquifers—underground water—is an even bigger deal than that. Think about it. Why might the discovery of an aquifer in the ground be important? Think back to our earlier Mystery.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to be a pioneer. You'll explore a new territory, where nobody lives. You'll start by collecting information. Then you're going to decide the best place to build a

town. Right now, you live in Rivertown, a place that's right on the river. When you first moved here, Rivertown was a small village. You knew everyone in town, and there was plenty of empty land. But the town has grown bigger and bigger and more and more crowded. Everyone moves here because they want to live by the river, where they can get fresh water for drinking and for their crops. But now there are too many farms and too many people. You want to go where there's more space. So you and a few friends have decided you're going to leave. You're going to head over the mountains, to the east of Rivertown, and find a place where you can build a new town. You've heard that there are no rivers and no lakes on the land on the other side of the mountain. And it doesn't rain much. When the rain does fall, it either evaporates or quickly soaks into the ground. You know that your new town will need fresh water. But you're not too worried. You and your friends plan to dig a well down to an aquifer, to get water from underground. But how will you know where to dig to find water? You know that underground water is close to the surface in some places. You don't have to dig too far to get it. In other places though, you have to dig really deep. And even then, you still might not reach water. You want to find a spot where there's water near the surface. But you don't have X-ray vision, you can't see what's underground. How can you figure out where to dig a well? You'll have to think like a scientist. You need to look for clues that indicate where there might be water underground. Thinking clearly, like a scientist, means gathering information before you make a decision. Luckily for you, a mapmaker just traveled through the land where you want to build your town. You'll get a map from him and decide where you think you should dig a well. You'll be making your best guess when you first look at the map. Then you'll get information from a few other folks in Rivertown. And what you hear from them might change your mind. That's fine. There's nothing wrong with changing your mind when you get new information. All right, let's get a move on it. I'll walk you through how this works, step by step.

ACTIVITY STEP 1

Form a team of up to four people. You're all tired of crowded old River Town, and you want to start your own town. Your team's goal is to decide where to dig a well to start your new town. If you're working alone, you're a team of one. You're a fierce solo adventurer, as brave as they come. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

It's time to gather some information. Remember that mapmaker we mentioned? Your team goes to the end where the mapmaker is staying. Ask for a copy of his map. It's in four parts. Get it from your teacher or parent now.

ACTIVITY STEP 3

The mapmaker shows you how to put the map together. Put the parts together like this so you can see the whole territory.

ACTIVITY STEP 4

The mapmaker points out that there's a lot of land to think about. To make it easier, if you're in a group, each person on your team will lead thinking and discussion on one part of the map. Take 15 seconds to choose a part. Now, if you have fewer than four people on your team, someone will have to look at more than one part. If you're working alone, you'll be in charge of the whole map. Okay, you have 15 seconds. Ready? Go. Time's up. Go to the next step.

ACTIVITY STEP 5

The mapmaker tells you: I used letters to mark every spot I thought would make a nice place for a town. Each letter marks a spot that you need to consider and evaluate. You'll get three sets of clues to consider. Your first clue is what the map shows, the features of the land. I'm talking about things like mountains, hills, valleys, canyons, flat plains. Now that you know all this, go to the next step.

ACTIVITY STEP 6

Now it's time to use what you know about underground water. Look at both spots on your part of the map. Answer question one for both spots. Now remember, your first clue is the land. Some spots are high in the mountains. Some spots are down in the low areas. So think about how far down you'll have to dig for water at each spot.

ACTIVITY STEP 7

All right, get one "Wanted, A Well" sheet for your group to keep track of what you figure out. You're going to talk about where there might be water underground. If you're in a group, one person will be the Recorder. Decide now who that person is, and get one copy of the sheet.

ACTIVITY STEP 8

If you're in a group, each person will take a turn telling the group how they answered question one for both spots on their map. Start with whoever has the Mystery Mountains map. How did you answer question one? Explain why you think that. Now, Recorder, your job on the Wanted

Water worksheet would be to cross off any spots where the group agrees that water is too far down to reach. Okay, go ahead and do this now for the Mystery Mountain map.

ACTIVITY STEP 9

Now it's time to hear from the Thirsty Hills map. How did you answer question one? Explain why you think that. Recorder, cross of any spots where the group agrees that water is too far down to reach.

ACTIVITY STEP 10

All right. Four spots down, four to go. Time to hear from the Dusty Flats map. How did you answer question one? Explain why you think that. And Recorder, cross off any spots where the group agrees that water is too far down to reach.

ACTIVITY STEP 11

Time for the last two spots. Let's hear from the Sandy Canyon map. How did you answer question one? Explain why you think that. Recorder, cross off any spots where the group agrees that water is too far down to reach. Now, just so you know, looking at the land gives you some ideas about where you don't want to dig for water. When you're done with this step, it'll be time for a new kind of clue, which you'll get in the next slide.

ACTIVITY STEP 12

Your team leaves the inn to go buy supplies for your trip. On the way to the store, you meet a naturalist, who's been traveling in the land beyond the mountains. She says the best way to figure out where there is water is to look at the plants. Some plants have long roots that reach

down to the water underground. Other plants rely on seasonal rainstorms. The naturalist tells you about what grows at each spot marked on your map. Get a copy of her list.

ACTIVITY STEP 13

Look at what plants grow on your part of the map. Answer question two for both spots on your map.

ACTIVITY STEP 14

Taking turns, each person talk about your answer to question two with your team. Recorder, cross out any spots that you all agree will not be good for a well.

ACTIVITY STEP 15

The naturalist says goodbye. You're getting closer to an answer, but you still have one more clue to go. Your team enters the hardware store where two miners are just back from a trip to the land beyond the mountains and they're buying supplies. They see your map and they ask where you're going. You explain. And one miner says: To know where to dig, you need to know about the ground. The miners tell you about the rocks and soil at each spot marked on your map. Get a copy of their list.

ACTIVITY STEP 16

Look at the rocks and soil on your part of the map. Answer question three for both spots on your map.

ACTIVITY STEP 17

Taking turns, each person talk about your answer to question three with your team. Recorder, cross out any spots that you all agree will not be good for a well.

ACTIVITY STEP 18

Now it's the time of reckoning. Will you find the perfect spot for a well, or will your town be the thirstiest town in the West? So, go ahead and discuss this. Where will you dig a well? Look at all the information you collected and all the spots you crossed out. Choose your spot, write down your reasons, and name your town. Think carefully. This is your final choice. If you choose wrong, your town could become a ghost town. No one can live where there's no water.

ACTIVITY STEP 19

Say goodbye to Rivertown. Your team heads over the mountains with high hopes. It's exciting and scary starting a new town. Have you chosen a good spot? Will your town well be dry? If you pay attention to your research, you should find an aquifer right near the surface. Watch the next video to find out whether you chose wisely.

WRAP UP VIDEO 1

So, where did you decide to build a town? When the Mystery Science team analyzed where to dig a well, we used a process of elimination. That means we started by crossing out some spots we thought wouldn't work. First, we looked at the land shown on the map. Now, some spots, like A and C, were up high on a mountain or a hill. We thought about how water flows downward going downhill, and then soaks into the ground. We figured that if you start digging at a high

spot, it would mean having to dig really deep down before you hit any water. So if you chose either A or C, we think your team will give up digging long before you hit water. Without drinking water your team doesn't survive. Let's look at the other spots. After thinking about the land, you found out about the plants that grow in different spots. Since we're looking for a place with lots of water, we decided to cross out any plants that are adapted to survive with very little water. Bristlecone pines and Joshua trees don't need much water. And they grow in spots we've already crossed out. Cacti or cactuses don't need much water. So we crossed out spot G. Wildflowers don't need water year-round. They grow and die. But we want water all the time, so we crossed out F as well. So if you chose either F or G, your town is going to be a pretty thirsty place. If you made your town there, you don't survive. That leaves us with B, where pickleweed grows, D, where greasewood grows, E, where willows grow, and H, where palms grow. Finally, we looked at the soil in each spot and that helped us narrow down our choices even more. In spot B, the soil was full of salt, and we know that people can't drink salt water and survive. So that spot is out. In spot D, the soil is salty and filled with poison. That's no good. So if you chose either of those, your town became a ghost town. Too bad. Spots E and H, with willow trees, gravel, palm trees, and sand. Both looked good to us. Now I decided to dig by the palms, where I found good fresh water. My town got named Dougville. Get it? Dougville? Okay, that was bad. It has water year-round. My friend Amy decided to dig by the willows, which has water right near the surface. She called her town Willowwash. The well never runs dry and the town is thriving. Where did you decide to dig?

WRAP-UP VIDEO 2

Now, all of this you did today was an imaginary activity, but it's also a model of what has really happened throughout time. For most of history, getting access to fresh water has been such a

problem that it has determined where we could even live and build cities in the first place. Just like the fictional city of Rivertown that was built on a river, all of the world's actual old cities were started near a source of scoopable fresh water too. The Babylonian city of Uruk was on the banks of the Euphrates River. Alexandria, Egypt, was on the Nile River. Tenochtitlan, the ancient Aztec city, was located on the Lake Texcoco in Mexico. London, England, is on the banks of the River Thames. The fact is, if you weren't within pretty short walking distance of scoopable fresh water, for most of history, that meant you couldn't live there. I mentioned in a previous Mystery modern cities like Chicago or Cleveland in the USA—they're located near these giant lakes, the Great Lakes. So they have no problem getting access to fresh water. Today, though, people manage to live just about anywhere, not just near lakes and rivers. In fact, many people in the world do not live within walking distance of scoopable fresh water. So where do they get their water from? From water that's in the ground: from aquifers. In an earlier Mystery, we saw how little of the Earth's water is fresh water. Now, though, when we also include the water that's found in aquifers, things don't seem nearly so bad. So many people can get fresh water from aquifers, water that's underground. They can build wells so that the water can be pulled up, whether by a rope or using a pump. Here you see him using a rope. This well is actually located in a desert, and yet they have fresh water down there, water that can be used for drinking and for farming. Look at this. It's incredible. Aquifers are important for a lot of people. The water that came out of the faucets in my house when I was a kid, that was well water. It came from the aquifer under where I lived. The faucets in your home might have water that comes from an aquifer, too. Try to find out. Ask around or search the internet. So, people get fresh water from lakes and rivers and from aquifers. Even so, could an aquifer ever run out of water? I mean, at some point, we're just going to slurp up all that aquifer water, right? That's a question we'll consider in a future Mystery. Have fun and stay curious!