Lesson: “Why do the stars change with the seasons?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! How many times have you been to outer space? I know the answer is zero times. I haven't either. So few of us have. But I dreamed of it from the time I was a little kid. I remember the first time I started to look out at the stars. It was a cold winter night. The sky was crisp. The stars were so bright. I liked looking at them because it was the closest I felt like I could get to outer space, pretending I was looking out the window of a spaceship. As you look around the sky, especially as you get away from bright city lights, you can see lots of stars. In ancient times, as people spent a lot of time looking up at the night sky, they realized they could use their imagination to connect some of the brightest stars, like this, to form shapes or patterns. You've probably heard of this before. We call these imaginary shapes *constellations*. Often, people would use these constellations to tell stories by the campfire. A few of these constellations might even be familiar to you, like this one here is Orion, “the Hunter.” See how it looks like a man with a bow and arrow? Here's another constellation you might know: it's the Big Dipper, which is actually part of a bigger constellation called Ursa Major or “Big Bear” because some ancient people had a special story about a bear with a long tail. Do you see it? Here's the nose and the long tail. Constellations used to be a tool for storytelling, but today they're a convenient way to map the sky, so anyone who studies space learns to identify them — especially scientists and astronauts. The constellation I was looking at that one winter night was Orion, a name originally

given to it by the ancient Greeks. My dad had a pair of binoculars, and I learned there are some cool things to see in and around Orion by pointing my binoculars in the right spot. Like, if you put binoculars or a telescope right here, you get to see this: it's a cloud in outer space that's been floating there for as long as we know — we call it the Orion Nebula. And if you look up here, do you see there? You get to see the Pleiades or “Seven Sisters.” You can see a cluster of stars, they're all next to each other. Now, to the eye alone, you might say there are only six or seven. You should go outside and try to count how many you can see. But when you get binoculars on it, now there are almost too many to count, and they sparkle as if opening a box of jewelry. So I got hooked coming outside every night looking at the stars, looking at all these things in binoculars. Orion became my favorite constellation to look at. A few months later, I went outside again and Orion wasn't there. It was totally gone. Had it gone forever? Where did it go? I was looking in the same place. The stars of Orion seemed to have disappeared, and now there were these stars there instead. I learned that these stars were a different constellation, Leo, which the ancient Greeks thought looked a bit like a lion that was lying down. Over time, I figured out something I hadn't known before: Orion didn't actually vanish. It's just that Orion is only visible in winter. By springtime, it had slowly sank below the horizon. And for some reason, Leo came out instead. It turns out that each season, we see different constellations. In other words, the constellations are *seasonal*. Orion is a winter constellation, and Leo is a spring constellation. What other constellations are there? Well, let's go on a quick tour of the night sky and see if you can find some of them. Your teacher will hand out a constellation guide to you now. Your class will use this guide when you discuss the questions on the next few slides.

EXPLORATION VIDEO 2

So, the constellations change each season. But why are they doing this? Where are they going? One possibility that might have occurred to you is that it's because the Earth is spinning. It's true the Earth is spinning; that was something figured out by two of the very first scientists, Copernicus and Galileo. But, actually, when you think about it, this wouldn't explain why the constellations change. Spinning does explain why the stars appear to move across the sky each night, rising and setting like the Sun. But notice that's not what we're talking about. We're not talking about a nightly change. We're talking about a change from season to season. We're talking about the fact that we only see constellations one season, then they're gone for a while, and then they come back a whole year later. This isn't repeating every day. It's repeating every year. Well, I need to tell you something more about Copernicus and Galileo. Not only did they discover the daily spinning of the Earth, they also figured out that the Earth is doing a second movement at the same time. It follows in a great circular pathway around the Sun, like this. We call this pathway the Earth's *orbit*. You can think of this orbit almost like a race track around the Sun. So the Earth does these two movements at once, spinning around like a top once a day, while also moving in an orbit around the Sun, like this. This second movement, the orbit movement, takes much longer to complete. It does this only once each year. To help explore the Earth's orbit further, you're going to get a cool handout, which your teacher will hand out now. This video is going to pause until everyone has the handout. Just press “Play” to resume. Now you should all have the handout. Later, you'll be cutting and folding this to make a tool, and we'll get to that in just a bit. But right now, just focus on the center of the sheet, right here where it shows the Earth orbiting around the Sun, just like in the diagrams we've been looking at. So let's figure out where the Earth would be located at different times of the year. So, right at this

position, the Earth is at the beginning of the year. So I'll label it January. And remember, it's going to take a whole year, or 12 months, for the Earth to complete one trip around its orbit and get back to the same spot it started at, right where it was the previous January. So each little blank on the handout represents one month. This part of the Earth's orbit is where the Earth is at in January, and this part in February, and so on. Go ahead and finish labeling the months now. I'll pause while you do that. Press “Play” when you're ready to keep going. Now that you've written in all the months, we want to think in terms of the seasons. Since the winter months are December, January, and February, let's put the word “Winter” above those months, like this. Now it's your job to write in the rest of the seasons. I'll pause while you do that. OK, now that you're done, do you have any more ideas about why we might see different constellations each season? Discuss this as a class.

EXPLORATION VIDEO 3

As for why we see different stars each season, here's one other big clue. Think about the fact that we can only see stars at nighttime, when the side of the Earth you're on has turned away from the Sun, like this. When you're right here, it's the middle of the night, and so you can see the stars. But when you're over here, now it's the middle of the day. You can't see any stars in the daytime because the Sun is shining so brightly. You can only see stars when you're facing away from the Sun. Are you starting to understand it yet? So the reason you only see Orion in the winter months is because the stars of Orion are actually located over here in this direction of space. And that's where the nighttime side of the Earth is facing during the winter months. Then the reason Orion disappears by springtime is because now the Earth has come over to this part of its orbit. When you look out into the night sky in spring, you're looking off into a new direction of the universe. You can't see Orion anymore. Instead, you see whatever stars are over here.

Stars like those in the constellation Leo. So, each season, as you go outside at night to look at the stars, you're looking off into a different direction of the universe. In summer, you're looking out in this direction, and so seeing summer constellations, like Scorpius. And in fall, now you're looking out into this direction, seeing constellations like Cygnus. You can see why one year later Orion appears to have come back. I mentioned before, you can think of Earth's orbit as a giant racetrack around the Sun. Now you can see, it really is like a racetrack, and it means the Earth is a lot like a spaceship, racing around on that racetrack. When you look out into the night sky, you're looking out the window of the spaceship, looking off into the universe. So every time you look at the stars now, you can take this bigger perspective on what you're seeing. You're looking out the window of a spaceship going in a giant racetrack around the Sun. Get outside tonight and look. What constellations do you think you'll find? From now on you can look at the stars from this new spaceship perspective. Which direction of the universe will you be looking out at from our spaceship, Earth? In the next video, you'll see how to make something to always help you remember. A Universe-in-a-Box.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to make a Universe-in-a-Box. This device helps you visualize the Earth's yearly orbit around the Sun. It's also a monthly calendar for the constellations. When it's all done, it works like this: you turn the dial to whatever month you want to see, and it shows you which constellations are out that month. This works because it's a model of the constellations and the Earth's orbit. Ready to make your Universe-in-a-Box? Here's what you do, step by step.

ACTIVITY STEP 1

Get your supplies. You should already have the box template, which you labeled with the seasons and months. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Take the sheet you wrote the months on and cut out the thick outer rectangle, like this.

ACTIVITY STEP 3

Cut on the four dotted lines. Be sure to stop cutting whenever you see a stop sign.

ACTIVITY STEP 4

Use your ruler to fold all the solid lines. Make a good crease on each fold by running your finger over the fold, like this.

ACTIVITY STEP 5

Cut out the circle. Here's a tip: you can turn the paper as you cut. It makes it easier. Then, carefully cut away the notch, like this.

ACTIVITY STEP 6

Take the box template and poke the brad through the Sun, and then turn it to make a larger hole. Then, take out the brad.

ACTIVITY STEP 7

OK, now poke the brad through the center of the circle. But whatever you do, don't turn it this time. Put it through the hole in the other paper, and then flip it over and separate the prongs so that they're flat against the bottom of the page, like this.

ACTIVITY STEP 8

OK, make the Universe-in-a-Box. Lift up the Universe-in-a-Box panel. Fold in the two “A” flaps. Then, fold the Universe panel down, like that, to secure it. And then, do the same thing to the other side, like this.

ACTIVITY STEP 9

Practice using your Universe-in-a-Box. Spin the brad on the bottom to turn it to different months.

ACTIVITY STEP 10

Use your Universe-in-a-Box to discuss the questions below. Discuss them in small groups first, and then as a class.

ACTIVITY STEP 11

Take a minute to think about the question below, and then discuss it as a class. The question is: What evidence do you have that the Earth orbits the Sun?

ACTIVITY STEP 12

Now that you have a Universe-in-a-Box, you can show it to others and explain how it works. So for your homework tonight, use your Universe-in-a-Box to explain to someone at home how you know that the Earth orbits the Sun. Have fun!