Lesson: “Could there be life on other planets?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! Let me tell you a true story. Halloween, 1938. At first, it was a night like any other Halloween in the United States. Children went out trick-or-treating, and after they came home, many families sat down as they did every night to listen to their favorite shows on this. Now, you see, back then, there were no television or computer screens. Those hadn't been invented yet. But there was radio, and as some people tuned into their usual evening radio programs, suddenly, they became very startled. What they heard was someone screaming on the radio. "Martians are landing! They're attacking!" As people heard this, many of them began to call their local police departments. "Is it true? Are we really under attack by aliens from the planet Mars?" We weren't under attack, as you might have guessed. What they'd been listening to was a reading of a fictional book, *The War of the Worlds*, written by the author H.G. Wells. The way it had been written, when read over the radio, sounded like a news broadcast, and that's why some people took it seriously and got worried. It wasn't intended to fool people, and not everyone was fooled. But enough people were worried that this gives you a sense of what people used to think we might find when we explore places in our solar system. Places like Mars, the Moon, and more. You see, back in those times, no human being had yet been to space. In fact, we hadn't sent anything into space yet. Our only knowledge of the planets depended entirely on what we could see through a telescope, and that left room for a lot of

guessing. Take Mars, for example, the red planet. Through a telescope, it looked a little blurry, but it seemed to have dark markings on its surface. No one really knew what to make of these. One astronomer wrote books and argued that these might be some kind of canals, or even tunnels constructed by intelligent Martians. Some people even published maps and named these. And it wasn't just Mars that people imagined things like this. For example, some people imagined that the planet Venus, since it's closer to the Sun than we are, might be a tropical paradise. Imagine an entire planet filled with jungle plants and warm beaches, even strange creatures. Maybe we could go live there one day. These days, though, we don't have to try to imagine what these places look like. Not only do we have rockets capable of sending things to space, we've actually sent robotic cameras to get close-up photos of every major planet in our solar system. We've even landed robotic cameras on Venus, Mars, and one of the moons of Saturn. We've discovered amazing things, things like the yellow skies of Mars, oceans made of flammable liquid on Saturn's moon Titan, an entire moon of Jupiter that's covered in ice, a volcano on Mars that's three times taller than the tallest mountain on Earth. And while it's been incredible exploring the planets and getting to see what they're really like, it's definitely not what most people expected. What people might have thought were Martian canals turned out to be simply dark features in the rock. If there ever were life on Mars, it's not there anymore, and there's no sign of it. Mars is one big freezing cold desert made of rock and sand. In most places on Mars, daytime temperatures rarely get above minus 80 degrees. Even Antarctica gets warmer than Mars. And Venus? It's no tropical paradise. Far from it. Robotic cameras sent there by Russia all melted within a few hours of landing on the surface of Venus. The temperature on the surface reaches nearly 900 degrees. That's twice as hot as a kitchen oven. As I mentioned, all of these images have been taken by robotic cameras that we've sent to these planets. They're controlled by remote control from people here on Earth. So far, the only place we

human beings have actually visited besides the Earth is the Moon. But if we ever were to travel to other planets and visit in person, it's clear that we would have to take a lot of precautions. Mars, Venus, any of the planets or moons, they all have conditions that don't make it easy for us to go visit. They're not exactly places that are habitable, good enough to live on. Based on what you know about the places in our solar system, would you visit any of these places? Where would you go, and what kinds of dangers would you have to protect yourself from?

EXPLORATION VIDEO 2

As we've explored our own solar system, we've discovered amazing things, but all of these places have turned out to be much more challenging places to visit than we ever imagined. None of the planets in our solar system have the same atmosphere that we have here on Earth. Mars' and Venus' atmospheres are mostly carbon dioxide. Almost no oxygen. Jupiter, Saturn, and the other gas planets don't even have a solid place to land. There's no surface. Just colorful swirling clouds of gas. Visiting these places ourselves in person wouldn't be impossible, but we'd have to take a lot of precautions. We'd need special suits to protect ourselves from intense heat or intense cold. We'd have to bring oxygen to breathe. And we'd have to make sure there's water. There's no place in our solar system quite like home. Earth is unique. But are there planets other than the ones going around our Sun? Like planets somewhere else in our universe? Planets not in our solar system? This is something that people have wondered about for a long time. As we look up at the night sky, we see hundreds of stars. Through a telescope, we see even more. Thousands upon thousands of stars all around us in every direction. As we've learned more and more about these stars, we've come to realize that our Sun itself is one of these stars. It just happens to be the star closest to us. If our star, the Sun, has planets going around it, couldn't other stars too? It's tempting to think, "Well, just point a really big telescope at

each star and look to see if there are planets." The problem is it's just not that easy. Each star is so far away from us that even if there were planets going around it, even the biggest telescopes aren't big enough to directly see any planets going around another star. All of that changed, though, starting in the 1990s. A few scientists came up with some really clever ways to detect a planet going around another star without actually seeing it. Now the details of these techniques they use are complicated. It doesn't matter too much. But if you're curious, one method they use involves carefully measuring a star's brightness and then noticing if the star's brightness dims ever so slightly. Basically, an eclipse. By using this and other techniques, scientists have been able to actually discover the first planets orbiting stars other than our Sun—what we call exoplanets, planets that are outside our own solar system. At first, these techniques only worked for finding really huge planets around other stars, planets as big or bigger than Jupiter. But over time, as the technology has gotten better, scientists have discovered smaller planets, too, ones that are Earth-sized. We've now realized that there are entire solar systems of other planets going around all kinds of stars. As of 2018, more than 4,000 exoplanets have now been discovered. And what's most exciting of all, dozens of these planets are a similar size and maybe even similar temperature as the Earth. What kinds of things will we find if we visit these planets? Alien life? Even if it's not intelligent aliens, could there be alien plants? Alien animals? And what if some of these planets were even places where we ourselves could live? Given that there are so many of these exoplanets being discovered, how should we decide which planets are the best choice to visit first? What do you think?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to plan a space mission to another solar system. Each of these solar systems has one star, just like our solar system, and several planets that orbit around that

star. You and your partner will both read up to become experts on a different science topic relating to each solar system. You'll need to work together to figure out which planets are going to be the best for us to live on and explore. Then you'll decide where you would go if you were leading a space mission. Choose carefully. You'll only get to pick one planet to go to. I'll walk you through how to get started, step by step.

ACTIVITY STEP 1

Find a partner. Decide who will be the Plant Pro, and who will be the Water Wizard. If you're working alone, that's okay too. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Get your supplies. Each group needs these things. You'll get more supplies later.

ACTIVITY STEP 3

Cut your Decoder off the side of your worksheet. Notice that there are different colors of gray on the Decoder. There are also these gray colors behind your planets. Your Decoder will help you figure out what each planet is like.

ACTIVITY STEP 4

Now it's time to read so that you can become an expert. Plant Pro: read the information about what plants would need to survive on another planet. Water Wizard: read the information about what temperatures are needed to have liquid water on another planet.

ACTIVITY STEP 5

Sometimes, when you read information, it can be helpful to circle or underline the most important information. Plant Pro: circle the important information about what percentage of light is too dim and too bright for plants to survive. Water Wizard: circle the important information about what temperatures are too hot and too cold for there to be liquid water.

ACTIVITY STEP 6

Use the information that you just circled to mark these conditions on your Decoder. Plant Pro: pay attention to the light levels on the bottom of your Decoder. Then, for each of these boxes, decide whether it's too bright for plants to grow, too dim, or just right, and write that above each box. Water Wizard: you'll pay attention to the temperatures listed along the bottom of your Decoder. Then, for each of the boxes, decide whether it's too hot, too cold, or just right for there to be liquid water. Be sure to write that above each box.

ACTIVITY STEP 7a

Now let's practice using your Decoder together. We'll use it on this planet, the planet closest to the star Malina. Match the color white to the white part on your Decoder, then decide if that planet would make a good place to live. Put an X if you think you can't live there, or a checkmark if you think you can live there. We'll take up this example together in the next step.

ACTIVITY STEP 7b

Okay, let's take it up together. Plant Pro, I'm guessing you found on your Decoder that it's too bright for planets and people to live on planets in the white zone. So you should put an X on that

planet. Water Wizard, I'm guessing you found that it's too hot to live on planets in the white zone. So you should put an X on that planet, too. Now, this time, both of you put an X, but as you do more of these you won't always have the same answer.

ACTIVITY STEP 8

Now use your Decoder to decide whether the rest of the planets have the right amount of light and the right temperatures to make them a good place to live. You'll draw an X over each one where you decide you can't live there. And use a checkmark if you decide you can live there. If there are any planets you are not sure about, you can put a question mark above those. You won't always get the same answer as your partner, and that's okay; work it on your own for now, and later you'll compare your decisions.

ACTIVITY STEP 9

All right, now get these supplies. Cut the Starlight Guide in half if it isn't already so that each of you has a copy.

ACTIVITY STEP 10

Talk with your partner about each planet. Together, you're going to mark which planets you definitely can't live on. If you decide you can't live there because of the light level or the temperature, find it on your Mission Plan and cross it out. Now, what if one of you had a checkmark, but the other one of you crossed it out? That still means it's not a good place to live, so you'll cross it out. If both the light and the temperature are good, don't write anything. You'll be left with more than one planet in the end.

ACTIVITY STEP 11a

When we planned our mission, we found that there were several planets in each solar system where we could live. Discuss questions one and two. Write your answers on your Starlight Guide worksheet.

ACTIVITY STEP 11b

Okay, let's take this up together. Here are some things that, hopefully, you noticed. All of the planets with the black background behind them are too cold and don't get enough light from their star. So, these ones you probably want to cross out. The planets on the white and pale gray background were also not great. They were too hot, and too much light reached them. So, you probably want to cross those out too. That leaves behind these planets. You might've noticed that the planets with the dark gray background, even though they might be warm enough, are too dark; they don't get enough light. So, you can cross those out. That leaves behind just these planets, the ones in the light gray areas. These are the planets that are potentially good places for things to live. By the way, there's an interesting pattern here, if you didn't already notice. All of the habitable planets by the star Malina are pretty far away from Malina. But, all of the habitable planets by the star Helios are pretty close to Helios. Notice why. Malina is a bigger, brighter star compared to Helios. So, the habitable planets are always far away from their star if their star is large and are always close to their star if the star is small. And that makes sense, right? It's because the light and heat from large, bright stars reach farther out into space than the light from small, dim stars. So, the location of habitable planets in a solar system depends on how large and bright the star is.

ACTIVITY STEP 12

Okay, it's almost time to make a choice about which planet you'd travel to. Remember, you only get to choose one planet, so you'll want to choose wisely. To do that, there's some more information that would be helpful before you make a final choice. Get this handout and cut on the dotted line. Then Plant Pro, you'll read the Spinning Specialist info. Water Wizard, you'll read the Gravity Guru info.

ACTIVITY STEP 13

Discuss the new information you just learned with your partner. On your Mission Plan, put an X on planets you don't want to live on. But don't make a final choice just yet. There's still one more thing I want to show you before you do.

ACTIVITY STEP 14

As a final piece of information, we received this picture from a satellite sent into space. This is a map of our star neighborhood. Traveling at the speed of light, it would take four years to reach Helios, eight years to reach Thea, and 20 years to reach Malina. Discuss, then choose one planet for your mission. Circle that planet on your Mission Plan. Remember, there's no right answer. Decide with your partner based on the pros and cons of the remaining planets.

ACTIVITY STEP 15

Discuss question three, then write your answer on your worksheet. Be sure to watch the final video.

WRAP-UP VIDEO

In the activity, everything we did was just hypothetical. The different solar systems we looked at aren't real places, but instead, just ideas were used to think about what kinds of conditions real planets might have. But there are real solar systems out there. We're discovering new ones every day. What would it be like to actually go on a journey and visit one? First of all, imagine as we left Earth, the farther and farther away we get from our own solar system, the Sun appears to get smaller and dimmer. As we keep traveling, eventually it becomes difficult to even tell our Sun apart from all the other stars. It appears as just another star among the thousands of stars in our local part of our galaxy. But what would it be like once we arrived at another solar system? Take for example a real-life solar system, one only discovered fairly recently by a team of scientists. It's called the Trappist System. And right away you'd notice some really weird differences with our own solar system. For one, the star at the center of the Trappist Solar System is a very different star than our Sun. It's smaller, and it's dimmer, too. Even the color of its light is different. It gives off a reddish-orange light. So, the view from one of the planets in the Trappist System would seem very alien to us. But maybe the biggest difference of all is this: the Trappist System contains several rocky planets all orbiting closely to their star. Even though the Trappist Star is dimmer and cooler than our Sun, these planets orbit closely enough that they're not too hot and not too cold. The temperature is just right for there to be liquid water on their surfaces. And they receive just enough light that plants might be able to grow and do well there. This zone where the temperature and light are just right for the survival of life as we know it is what scientists sometimes call the Goldilocks zone, as in Goldilocks and the Three Bears, the story where Goldilocks goes into the bears' house and tries different things that belong to the bears, like the three bowls of porridge. One is too hot, one is too cold and one is just right. What

would we find if we one day traveled to the Trappist System and actually landed on one of the planets in its Goldilocks zone? Just imagine if one of the planets actually made a good place to live. Say that it was nice and warm and even had oxygen to breathe. What kind of view would you wake up to each morning? What color would the sky be and what would you see? And all of this is just considering us living on one of these planets. But what if when we land, there's already life growing and surviving on that planet? Obviously, it would be completely amazing if we were to ever find intelligent life, beings that we could communicate with and learn from. But even if we didn't find intelligent alien life, just any kind of alien life at all could be incredible to see. Could there be alien trees, alien flowers, alien insects? What kinds of alien life might we find? Nobody knows, and at least for now, it's anyone's guess. We can let our imaginations run wild. I'll leave you with this to think about. Maybe one day, in the distant future, you'll be present when we make the journey to one of these faraway planets. Have fun, and stay curious!