Lesson: “How do you send a secret code?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Jay from the Mystery Science Team. If you wanted to send a secret message, how would you do it? Maybe you'd use invisible ink that glows under a special light or try writing backwards. Your friends will need a mirror to read it or maybe you'd invent your own code. When I was a kid, I loved to send my friends secret messages in code. I'd use numbers to stand for different letters, then spell things out like this. That's code for "Hi, it's Jay." These days, I'm curious about a code I see constantly. It's this stripy thing. You probably know it's called the barcode. You may have seen them on cans of soda, delivery boxes, library books. It seems like barcodes are everywhere. Even though code is in the name, it's not really clear what kind of code a barcode is. Code makes me think of secret messages, but when I see a barcode in action, it's usually at a store and looks something like this. A device gets pointed at a barcode. There's a flash of light. Then information comes up on the computer screen. Not exactly secret spy stuff, but how this works is definitely a mystery to me. To figure it out, let's take a closer look at some barcodes. They usually look something like this, but there are some wild barcodes out there too, like this one that looks like spaghetti, or this barcode that's a bird cage–and here's one that's grass being mowed. Look closely, they seem pretty different, but what do you notice is the same about all these barcodes? Do you notice any kind of pattern?

EXPLORATION VIDEO 2

You may have noticed that all the barcodes, even the fun ones, have a pattern of black and white lines. That pattern is a code. Some barcodes work in slightly different ways. We're going to zoom in on part of this one. You may notice that some lines look thinner, like this white line, and some look thicker, like this black one. But that thick line is actually three thin lines of the same color. If you could spread the pattern out and see its individual parts, it would look like this. Check it out. All the lines are the same size. The entire pattern is made of just two basic parts, black lines and white lines. At first, black line / white line may not seem like much of a code, but those two parts can be put together in lots of different patterns. Think about the English language. In a way, it's like a code. The alphabet only has 26 letters, but by putting them in different combinations, you can create thousands and thousands of different words. By putting together different patterns of black lines and white lines, you can create many different barcodes, enough for every book in a library or every box in a warehouse or every item in a store. In fact, the reason you see so many barcodes at the store is that they help keep track of all the different things being sold. Each kind of item gets its own specific barcode. So a barcode is like an item's name tag. Okay, now that you know the pattern is a code, take another look at that video. It looks like somehow that code gets to the store's computer, but here's the thing, the barcode and the computer can't really communicate with each other. It's kind of like being with two friends who don't speak the same language. If you know both languages, you can be a translator. When your friend who speaks Spanish wants to ask, "Como estas?" you can understand her and pass her message to your friend who speaks English. You can translate “¿como estas?” to “How are you?” The message stays the same. You just changed the language so your friend can understand. Here, it's like the barcode has its language, black lines

and white lines, but the computer speaks a different language. We need some way to translate black and white lines so that the computer can understand. Fortunately, there's a translator to help. It's that flashy light part we saw earlier. This device is a barcode scanner. The scanner can read the barcode and translate it into something the computer will understand. But how? What do you think? How does the scanner translate the black-and-white pattern into something the computer understands?

EXPLORATION VIDEO 3

So how does the scanner translate the black and white pattern into something the computer understands? It's a tricky question. Maybe you guessed it has to do with that flash of light from the scanner. You're right. That's how it starts. The scanner sweeps the light across the black and white lines to read the pattern. It's like when you understand your friend's message in Spanish. Next, the scanner needs to translate the pattern into something the computer can understand. This part is even trickier because it's something you can't see but it's something you likely know computers use: electricity. The scanner turns the pattern of lines into a pattern of electricity. For instance, when the scanner reads a black line it can send a pulse of electricity down a wire to the computer. That's like sending an “on” electrical signal. And when the scanner reads a white line it doesn't send an electrical pulse. That's like sending an “off” electrical signal. So a pattern like black, white, white, black, black, black, white, can become electrical signals on, off, off, on, on, on off. The scanner sends the pattern of electrical signals along a wire to reach the computer, like when you pass the message along in English. Finally, the computer can understand the pattern and decode it. That code stands for a specific item in the store. It lets the computer know which item you're buying. The info that comes up on your computer screen has the item's name and how much it costs. Now you can quickly tell the difference between soup

and a soccer ball. You could feel the container or see it or read soup on its label. But most computers can't do those things. They can only recognize an item by its code. This is why a barcode is like an item's name tag. Only the computer can't read the name tag on its own. It needs the scanner to translate first. Then the computer can tell things apart. When the scanner reads a barcode it translates a code of black and white lines like this into electrical signals like this. Electrical signals going on and off might seem really different from black and white lines, but take a closer look. What do you notice? What's the same about these two patterns? What's different?

EXPLORATION VIDEO 4

Earlier you discovered that a barcode is made of two parts, black lines and white lines. Maybe you spotted that the scanner's code is also made of two parts, electrical signals on and electrical signals off. And even though they're made of different things, these patterns match. You may have noticed that in this example, the on signals take the place of the black lines and the off signals take the place of the white lines. It's the same pattern as a barcode. The scanner just translates black and white into something the computer can understand, electricity. Since both of these codes are made of two distinct parts, the scanner can translate the exact pattern from one form to another. A code with two parts is really useful and it's not just for scanners and computers. You and your friends could come up with your own code. As long as you keep the pattern the same you could send a message using just about anything for the two parts of the code. Instead of black lines and white lines. You could use a pattern of carrot and celery or try right-eye winks and left-eye winks. You could bounce it on a trampoline with high bounces and low bounces, or train your pets to pass the pattern. Imagine what else you could use.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you and a partner are going to create your very own secret codes. You'll get a list of secret snacks. Each snack has a special pattern of black boxes and white boxes, just like a barcode. But today, you're not going to use black and white as your code. Your challenge today is to create your very own codes. First, you and a partner will create a code that you can see. Maybe it's two colors or two dance moves. Then, you and your partner will create a code that you can hear. Maybe it's a clap and a snap, or two different kinds of pencil taps. Your code can be just about anything, as long as it has two distinct parts. Once you create your codes, you and your partner are going to walk across the room from one another then you'll each choose a secret snack. Your challenge is to communicate what your secret snack item is using only the codes you created. It might be tricky because you'll be standing far away from your partner. Your goal is to compare the two codes and figure out which one is the best solution to communicate with your partner. Are you ready for the secret code challenge? We'll show you how to get started, step by step.

ACTIVITY STEP 1

Today, you'll work with a partner. Decide who will be decoder A and who will be decoder B. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Get your supplies.

ACTIVITY STEP 3

First, get your Snack Decoder, and examine it closely. This shows the pattern of black boxes and white boxes that is the code for each snack. Your challenge today is to send the exact same pattern, but turn the black-and-white boxes into something different. For example, maybe a black box equals a smile, and a white box equals a frown. We'll do a practice round together in the next step so you'll know what to do.

ACTIVITY STEP 4a

Okay, I'm going to communicate my secret snack using a new code. In this code, a black box equals a smile and a white box equals a frown. You and your partner need to figure out which item is my secret snack. You can use the back of your snack decoder if you need a place to record what you see. When I'm ready to send the code, I'll say start. And when I'm done, I'll say stop. Okay, here we go. Start. Stop. This video will keep playing so you can see the pattern again. Watch carefully and discuss with your partner what you think my secret snack is. Start. Stop. [Repeated]

ACTIVITY STEP 4b

Here's what you might have noticed. The code I sent was frown, smile, frown, frown, smile, because a smile equals a black box, and a frown equals a white box. That translates to white, black, white, white, black. If you look for that code on your snack decoder, that pattern stands for apple. My secret snack is an apple. You might have noticed that the two frowns back to back were a little difficult to tell apart. Keep this in mind for when you communicate your code to your partner later in the activity.

ACTIVITY STEP 5

In a moment you're going to brainstorm different kinds of visual codes and different kinds of sound codes. Before brainstorming, it's important to know two things: your criteria and your constraints. When you play a game, you need to know how to win. We call that the criteria. It's how you'll know you succeeded. Your criteria for this challenge is to communicate your secret snack to your partner from across the room. For the visual code, you can use only your eyes to see the pattern. For the sound code, you can use only your ears to hear the pattern. When you play a game, you also need to know what the rules are. We call those the constraints. Today, there are three constraints. Number one, you have to make sure you and your classmates stay safe during the activity, number two, you must stand across the room from your partner, and number three, you have only certain materials to use for your codes. For example, you might have crayons and scissors. You might have slightly different materials and your teacher will tell you exactly what materials you have right now. Take a moment to review what materials you have today.

ACTIVITY STEP 6

Now that you know your criteria and constraints, it's time to brainstorm. First, you'll brainstorm ideas for codes that you can see. I used a smile and a frown for my code, but maybe your team will use thumbs up and thumbs down, or a red star and a blue star, or two different dance moves. Find your visual code worksheet and write down as many ideas as you can on the back. Try to come up with at least four different ideas. I'll set a timer for three minutes in case that's helpful. Okay, time's up. Click the arrow on the right when you're ready.

ACTIVITY STEP 7

Discuss your ideas with your partner, and decide together on your favorite idea. That's the one you'll use in the activity. You have to decide on one visual code that you'll both use. Write that down on your Visual Code Worksheet here in Section 1. Make sure you and your partner write down the same information.

ACTIVITY STEP 8

Before you use your visual code, you first need to brainstorm your sound code. Your sound codes need to be made of two distinct sounds, but there's one more constraint this time. You can't use any sounds from your mouth, so you'll have to be creative and think of other ways you can make sounds. For example, maybe a black box equals a clap, and a white box equals a snap, or a black box equals two pencil taps, and a white box equals one pencil tap. Write down all of your ideas on the back of your sound code worksheet. Try to come up with at least four different ideas. I'll set a timer for three minutes in case that's helpful. Okay, time's up. Move on to the next step if you're ready.

ACTIVITY STEP 9

Discuss the ideas for your sound code with your partner. Decide on your favorite idea. That's the one you'll use in the activity. In section one of your Sound Code worksheet, write down what sound will equal a black box and what sound will equal a white box. Make sure you and your partner write down the same information.

ACTIVITY STEP 10

Before you send your codes, you need to repair any materials that you might need. For example, if your visual code uses the colors blue and red, you each need something that is the color blue and something that is the color red. Remember, you'll be standing across the room, so you need two sets of materials. One for you and one for your partner. You may also want to use this time to practice hearing the sounds for your sound code. Remember, you won't be able to see your partner. You'll only hear the sounds. When you're ready, click the arrow on the right.

ACTIVITY STEP 11

In a moment, you're going to walk to the opposite side of the classroom from your partner. Your teacher will tell you exactly where to stand. Make sure you bring all of your materials with you.

ACTIVITY STEP 12

It's time to choose your secret snacks. Look at your Snack Decoder and silently choose one item. Write a 1 next to it. This is the snack you'll communicate to your partner using your visual code. Then, choose another snack and write 2 next to it. This is the snack you'll communicate to your partner using your sound code. Remember, these are secret snacks, so make sure you don't tell your partner.

ACTIVITY STEP 13

Get your visual code worksheet and find section two. Then look at the first snack you chose. Write down how you will communicate your secret snack to your partner. For example, if your code is that a black box equals a smile and that a white box equals a frown and your snack is

the pretzel you would show your partner a frown for a white box, a smile for a black box, and then three more frowns for the white boxes. So write or draw how you'll communicate your secret snack using your code in the five boxes here.

ACTIVITY STEP 14

Now, get your sound code worksheet and find the second snack you chose. In section two on your sound code worksheet, write down how you will communicate this secret snack to your partner using your sound code.

ACTIVITY STEP 15

Now you're going to send your visual codes. This step is a little complicated, so we suggest you watch the whole thing before doing anything. Decoder A, use what you wrote in section two to send a message to your partner. Say, "Start," do the five things in your message, then say, "Stop." Decoder B, as your partner sends you the code, record it in section three on your visual code worksheet. For example, if you see your partner doing this, you would write that here. Decoder A, we suggest you send the code at least twice so that your partner can double-check it. Okay, now it's your turn. Remember, you can only communicate with your visual code, no other talking allowed. When you're done with this step click the arrow on the right.

ACTIVITY STEP 16

Okay, now it's time to switch roles. Decoder B. Using only the visual code, you need to show your partner what your secret snack is. Decoder A. As your partner sends you their code, record it on your Visual Code Worksheet in Section 3. When you're done, click the arrow on the right.

ACTIVITY STEP 17

All right, it's time to figure out what your partner is hungry for. Did they choose a banana, or popcorn, or something else? Both of you, look at the pattern you recorded in Section 3 of your Visual Code Worksheet, then find that pattern on your Snack Decoder. Write down what you think your partner's secret snack is here in Section 4. Don't tell them what you think it is just yet. You'll compare answers later.

ACTIVITY STEP 18

Okay, now it's time to communicate your secret snack using the sound code you came up with. Decoder B, turn around so you can't see your partner. You're only going to hear the sounds. Decoder A, using only your sound code, you need to communicate what your second secret snack is. Decoder B, as your partner sends you the code, record it in section three on your sound code worksheet, then make sure to switch roles.

ACTIVITY STEP 19

All right, it's time to figure out the second secret snack your partner is hungry for. Did they choose cookies, or carrots, or something else? Both of you, look at the pattern you recorded in section three of your Sound Code worksheet. Then find that pattern on your snack decoder. Write what you think your partner's secret snack is here in section four. Don't tell them what you think it is just yet. You'll compare answers in a moment.

ACTIVITY STEP 20

Okay, now that you've sent your codes to one another, it's time to sit back down with your partner. Once you're back in your seat check to see if you were able to figure out which items were their secret snacks. If you got some wrong, that's okay.

ACTIVITY STEP 21

Discuss. What was easy about sending and decoding your messages? What was difficult about sending and decoding your messages?

ACTIVITY STEP 22

You sent your codes across the room, but what if you tried to use your codes in other locations or in different conditions? Discuss as a class, then complete question five on your visual code worksheet. Where and when might a visual code work better than a sound code? Why?

ACTIVITY STEP 23

Discuss as a class, then complete question five on your Sound Code worksheet. Where and when might a sound code work better than a visual code? Why?

WRAP-UP VIDEO 1

In the activity, you and a partner created codes, then used them to send a message that revealed your secret snacks. With everyone using their codes at the same time in one room, it may have sounded something like this. In all that noise, you may have found that visual codes

were easier to use than sound codes. There were lots of sounds all mixed together. It may have been hard to tell which ones came from your partner and which came from other teams. Then again, if you needed to send a message in the dark those sound codes would be really useful. But imagine if we added a different constraint. What if we kept increasing the distance between you and your partner? Instead of sending your code across a room, you'd have to send it across a playground or even across town. That seems really hard, maybe even impossible but I'm guessing you've sent lots of messages back and forth across town, maybe even across countries. You just need these, cell phones. When you speak on the phone, your voice creates a pattern of sound. The pattern of sound goes into the cell phone. Then, sound comes out again from the other phone. Seems simple enough but have you ever stopped to wonder how that happens? There aren't any wires connecting the two phones yet somehow the message gets from one to the other. It's actually a bit like what you did in the activity. This might seem very different, but instead of two phones let's picture you and your partner. In the activity, you picked out your secret snack like an apple. Your snack came with a code of black and white boxes and you needed to send that message to your partner. But there was a challenge. You couldn't just send the black-and-white code. Instead, you had to send the message across the room using a new code that you created like smiles and frowns and whatever code you used you had to make sure the pattern for your secret snack stayed the same. Your partner needed that pattern to find the right snack. Now, if you think about a cell phone it has a similar challenge. It's starting out with a pattern of sound made when you speak, but it doesn't just send your message the way it is as a sound. I mean, imagine if every cell phone blared super loud sounds to send them across town. Yikes. Instead, the phone changes the pattern of sound into a pattern of something else. But what? To get an idea, it might help to think back to what you learned about the barcode scanner and how it sends a message to the store's computer.

WRAP-UP VIDEO 2

Earlier you saw how a barcode scanner translates a pattern of black and white lines into a pattern of electrical signals. That's how it gets a message to the store's computer. A cell phone does something similar. It changes a pattern of sound into a pattern of electrical signals, but those electrical signals can't travel through the air to your friend. So next, the phone changes the electrical signals into another kind of signal. Radio signals, they're important because they can travel long distances through the air. No wires needed. Even though it changes from one kind of signal to another, the pattern being sent stays the same. It's still the message you spoke. That means when we talk on the phone there are invisible patterns traveling back and forth in the air all around us. How cool is that? The pattern of radio signals reaches your friend's phone and gets changed back into a pattern of electrical signals, but your friend can't hear those electrical signals yet. Before your friend can hear your voice, the phone needs to change the pattern of electrical signals again. This final step is similar to what your partner did to figure out your secret snack. What do you think happens next inside the phone?

WRAP-UP VIDEO 3

In the activity, your partner had to decode your message to figure out your secret snack. First, they turned the code you sent back into a code of black and white boxes. Then, they matched that pattern to a secret snack. Hey, an apple. They got your message. Now, the phone needs to decode a message too. It needs to change the pattern of electrical signals back into a pattern of sound. The pattern of electrical signals gets sent to a speaker inside the phone. The electrical signals make the speaker shake, and the shakes create the sound of your voice. Now your friend can hear what you said. It's pretty amazing to think that the pattern of your voice can get

turned into a code of electrical signals, then passed along as a pattern and finally decoded back into sound. It's especially incredible when you remember how fast this all happens. Your friend hears your voice almost instantly. Your secret snack codes probably didn't go as fast. It took some time to send and decode them, and it might have felt a little goofy using dance moves or pencil taps to send a message. But really, you were thinking like inventors and engineers. You had to solve the problem of how to communicate your secret snacks across a room. Devices like cell phones and computers were invented to solve a similar real-world problem, how to communicate long distance without losing important information. You've seen how patterns can be used to stand for specific information, whether it's a barcode that stands for an item at the store, or a pattern of smiles and frowns to communicate your secret snack, or even patterns that carry the sound of your voice from one phone to another. So the next time you pick up a snack at the store or check out a book at the library or chat with a friend on the phone, think about the patterns that make all those things possible. Maybe you'll put patterns to work by creating your own secret code. Keep decoding, and here's one last secret message for you to solve.