Bay Area Scientists in Schools Presentation Plan

Lesson Name Sailing Clips, Pepper Fish, Penny Drips
Presenter(s) Shervin Fatehi

Grade Level 1 **Standards Connection(s)** 1: properties change with mixing

Abstract: Lots of things sink in water: rocks, sugar cubes, and even people. This has to do with density, how much something weighs compared to how big it is. A leaf in a puddle or a boat on the ocean is light enough for its size to float! Sometimes, though, things that should sink because of density (like a paper clip) will float anyway if we put them in water in a specific way. This is because of surface tension – the main idea we'll explore together. I'll show you how to float a paper clip "boat" and some pepper flake "fish" and then sink them with some soap – we'll learn just by playing with little things in water! Then you'll use pennies to explore surface tension when there's much less water around than other things.

Vocabulary/Definitions:

Density (implying buoyancy) – How heavy something is compared to how big it is. (One reason we can sink in water.)

Water surface – Where water and air touch. (There are other surfaces, like water/glass, skin/air, etc.)

Surface tension – The water surface resists letting things through, like a "skin." (This can prevent sinking.) Surface tension is also the reason that water turns into beads on blades of grass or car hoods – the water wants to stick together.

Cheerios effect – Small things (like pepper flakes or Cheerios) on a surface tend to clump together. (Because of surface shape, among other things.)

Materials: *What you'll bring with you / What students should have ready (pencils, paper, scissors)*

A pitcher or other large container for water would be great, as would easy access to a sink. Paper towels to use during the hands-on portion of the lesson would help, although I can bring a dish towel.

For the demonstration: I'll bring a glass baking dish, two or three paper clips, a metal or plastic fork, a dash of pepper, and some dish soap. Students don't need anything to participate.

For the hands-on activity: I'll bring plastic eye droppers, some pennies, and maybe some small cups for water. I'll also have a straw to show them how to use it as a dropper if they want to explore these ideas more at home, although I may well have enough droppers to leave some. Students should have a pencil and a piece of paper ready to take down their observations.

Classroom Set-up: *Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed*

Setup time for both activities should be minimal – maybe 5 to 10 minutes total. For the demo, I need to fill my container(s) with water and (for maximum effect) place them on an overhead projector that you'll provide. For the hands-on activity, I can divide the eye droppers and pennies into bags for each group as appropriate (as long as I know the size of the class ahead of time); then I can fill up the cups directly beforehand so there aren't any spills during the demonstration.

Classroom Visit

1. Personal Introduction: _____5____ **Minutes**

Hi! I'm Sherv. I'm a scientist – specifically, I'm a chemist. I like listening to and playing music, reading, and playing basketball, but my job is doing science. I actually sit down each day and try to figure out how the little pieces that make up everything from this desk to the oceans move! One of the things that interests me most, though, is water. I'm here with you today to explore how cool water is, and I hope you'll agree when we're done that even things we see every day are worth studying scientifically!

Topic Introduction: _____10____ **Minutes**

Big Idea(s), vocabulary, assessing prior knowledge. What questions will you ask to learn from students?

Everybody here has probably taken a bath before (don't raise your hand if you haven't!), so we know what it's like to be in water. Most of the time, we sink. What are other things that sink in water? [Take some answers.] What can we say about those things? What is it about them that you think makes them sink? [Take more answers – if weight or size comes into it, write "density" on the board.] These things are related to a concept called density. Basically, it's how heavy something is compared to how big it is. Rocks are dense compared to water – a rock weighs more than the same sized amount of water -- so they sink.

But being dense isn't the same as being heavy. Sometimes, heavy things can float – like boats do in the ocean – because they're light for their size. Do any of you know how to float? [Take answers.] Usually when we float, we try to lie on our backs in the water. What we're doing is adjusting our size – we're "bigger," in a way, than if we're wading and standing up, and so our density seems to get smaller.

What other kinds of things float? [Take answers...] Right! Leaves and feathers and tiny insects all float. They're not dense at all. But they're different from boats or people because, usually, they're not actually "in" the water. They're "on" it – that is, on its surface. [Write this on the board.] Can anybody tell me what a surface is? [Try and work toward the idea.] Right – the water surface is the place where it just touches the air.

2. Learning Experience(s): **15 Minutes**

Demo:

Let's take a few minutes now and explore the idea of the water surface more. I've got a dish of water sitting on this overhead projector. I'm going to show you that we can turn a paper clip into a little boat on the surface. First I'll try just dropping the paper clip into the water. [Do it.] See what happens? It sinks! What does that mean? [Pause for answers.] That's right – the paper clip is dense compared to the water. But watch this... [Lower the paper clip in slowly using the fork or another paper clip.] I made the second paper clip float! What did I do differently? [Answers.] I put the paper clip on the water slowly, and I made sure it had its long edge touching the water – I adjusted its size, just like we do when we float. But unlike us, the paper clip isn't in the water. It doesn't break the surface and push some water out of the way. The clip is sitting *on* water, just like it might sit *on* your skin if you put them in your hand. [Draw a diagram of this.] So what do you think it means that our boat doesn't sink? [Answers.] Right – the water is resisting the paper clip's tendency to sink. This is called "surface tension" -- the water surface doesn't like to be broken, and it acts like a skin that keeps the clip from falling through. Actually, water has an unusually *big* surface tension, and that's just one of the many unexpected facts about water, aside from the fact that we need it to live, that make it so important.

Now how about these flakes of pepper – little fish to go with our boat – do you think they'll float on the surface, too? [Answers.] Let's see. [Shake out some flakes.] They do! Do you see anything interesting happening? [Answers.] Some of the flakes are clumping together. Some of the flakes are heading toward the walls. And some of the flakes are collecting around the paper clip, like a school of dolphins swimming alongside a ship. These are all examples of the Cheerios effect – small things like pepper flakes, paper clips, and bubbles all tend to clump together when they're on the water surface. Can you think of any reasons that might be? [Answers.] It has to do with the shape of the surface and how it changes when things float on it. The paper clip makes little dimples in the surface that the flakes tend to fall in to. [Update diagram.] And there's usually an overall dip in the surface as you go from the edges of the glass to the middle – it's called a meniscus. [Update diagram.] So the water surface has a really complicated shape!

One more thing, and then we'll look at something new. [If the ship sinks due to the flakes clumping, float another one or use a different container.] I have a little dish soap here. What do you think will happen if I put a drop of it in with our boat? [Answers.] It sinks! What's more, the flakes all got pushed out to the sides of the glass and then started to sink, too. What happened is that the soap formed a surface of its own next to the water, and this decreased the surface tension – it made the water "skin" easier to pierce. Adding something to water can change its surface tension.

Hands-on:

Now let's do an experiment. I'm going to split you up into groups of (however many seems appropriate – two is best, I think). I have a bag for each group with a dropper and a penny in it. I

also have cups full of water, one for each group. So one of you will come up and get the bag, and one of you will get the cup – carefully. [Count them off into groups.]

What we're going to do is this. The person who got the bag will drop water onto your penny, heads side up, one drop at a time. The person who got the cup will count how many the dropper can fit before the water drips off of the penny – count by making tick marks on some paper, like this. [Demonstrate.] It doesn't make sense to count a big drop the same as a little drop, so as a scientist, you should try to keep your drops the same size. When the water drips off of the penny, write down how many drops it took. Then I'll tell you to switch jobs. Dry off the penny and try again. While you're doing this, watch the surface of the water! What's it shaped like? How does the drop grow? [Repeat instructions, perhaps with a quick demonstration of the procedure.]

[Do the activity.] Okay, one more thing. Write down whether your penny was dirty or clean.

3. Wrap-up: Sharing Experiences and Building Connections _____10_____ Minutes

Before we look at the results, what did you notice? [Go over answers.] Right. The water started out as a bead, small, with a very rounded surface. As you added drops, it spread over the whole penny, and it wasn't as round. Eventually, it might have gotten so big that the surface was dipping out over the edge of the penny. And finally it broke. This is all because of surface tension! In addition to making the surface act like a skin, surface tension keeps water from spreading around too much – the water wants to “stick together.” It turns out that a round shape is the best way to do that.

Now let's look at the data – the numbers from your scientific experiment. Which groups had dirty pennies? [Write on the board.] Which groups had clean ones? [Write on the board.] I'll ask each group to tell me how many drops they got now. [Write this down.] Do you see any trends? That is, do the numbers say that clean pennies or dirty pennies hold more drops? [Discuss. Maybe the grime is disrupting surface tension like the soap did.] Isn't that neat? And it's really a scientific approach.

4. Close: _____5_____ Minutes

If you're still curious about surface tension, here are some ideas you could try at home (you can use a straw as a dropper if you put your finger over the end – like this). [Demonstrate.] We (may) have seen that dirtier pennies seem to hold different numbers of drops from clean ones. Think about what would happen if you rubbed dish soap on a penny before doing our dropper experiment. Do you think you'd be able to get more or fewer drops to sit on the penny? What about if you used the “tails” side of the penny instead of “heads”? They have different designs. Do you think that would matter? And what do you think happens to the surface tension if water is colder or warmer than room temperature?

These questions are all fun to think about, and the neat thing is that they're all scientific questions! I've spent lots of time studying how water surfaces act, and so have many other scientists. Some of them say that we may be able to use the Cheerios effect to build things – really tiny things! That's something else for you to think about – how could that work?

Thanks for having me. I hope you had fun! (Clean-up ensues.)

TOTAL ~45 Minutes

Follow-up – After Presentation

Suggest students write a letter explaining "How we learned about _____?"
List or attach examples of activities, websites, connections for additional learning.
Attach worksheets, hand-outs, visuals used in classroom presentation.

Writing a letter sounds good – I like getting mail!

Also, the entire wrap-up question can be eliminated and turned into a handout for any teacher who prefers that approach. In that case, I'd just mention that I've prepared a handout full of fun questions that also happen to be scientific ones, and I'd also demonstrate how they can use a straw as a dropper.

Reading Connections:

- A Drop of Water by Walter Wick http://www.amazon.com/Drop-Of-Water-Science-Wonder/dp/0590221973