**December Puzzling Phenomenon:  Mysterious M&Ms**

*Concept*

Properties/interactions of matter, specifically solubility and possibly density

*Introduction & Phenomenon*

I was snacking on some M&Ms and accidentally dropped a few into my cup of water. Before I could fish them out and get a fresh cup of water, my mom called and I talked to her on the phone for about 25 minutes. When I returned to my ruined water, I was perplexed by what I saw. Instead of describing it, I think it would be more fun to show you what I found in my cup.

View the following video, or do a demo of what you see in the video: <https://www.youtube.com/watch?v=z664hPVeBVA>

Show with mute on, to avoid hearing the explanation; best to play from about 25 seconds to 1:30. The video is less dramatic than watching it happen in real life, but it is quicker because of the time lapse.

What you see essentially happens in two steps. First, the color on the outside of the M&Ms gradually comes off the candies and flows into the water directly under and around them, mainly on the bottom of the cup. (Some mesmerizing videos of this phase can be found here: <https://www.youtube.com/watch?v=031Xr1zqbJ0> ) Then if you wait long enough, you’ll see the white M (which remains, and doesn’t come off with the color) detach from the candy and float up to the surface of the water.

*Explanation of science involved*

The dye on the candy coating of M&Ms is soluble in water. So as the M&Ms sit in the water, the polar water molecules gradually dissolve the polar dye molecules. Here’s a helpful animation of this in action: <https://www.youtube.com/watch?v=umJmRaG6v80> (watch 1:26 to 1:50). This dye is also more dense than water, so it stays on the bottom of the cup, rather than mixing freely around the cup or floating to the top. In contrast, the M is actually made of an edible paper that is not water soluble, so it does not dissolve in water. But once all the dye (which essentially acts like a glue for the M to stick to the candy) has dissolved, the M detaches from the candy and floats up to the surface of the water. It floats because the edible paper is less dense than the water.

*Further Ideas for Classroom Use*

This puzzling phenomenon could be used during a physical science unit on matter and interactions (or properties of matter). Some physical properties are highly accessible for students, such as color, state, texture and odor, and therefore provide a nice place to begin an interactions of matter unit. But others, such as solubility, polarity and density, are less obvious and require some manipulations or careful measurements to “see.” Watching the M&M dye dissolve in water, and then the white M float to the top could be a rich jumping off point for this more difficult tier of physical properties before moving onto chemical properties and changes. After showing the video or allowing pairs or groups to place and carefully observe M&Ms in water themselves, some discussion questions might include:

1. How are the dye molecules interacting with the water molecules as the color moves off the candy and into the water? (Drawing could be a useful way to elicit thinking on this one.)
2. Why does the white M initially stay on the candies unlike the bright colors? When it eventually comes off, why does is float to the top instead of sinking to the bottom?
3. How might the substance that makes up the dye be different from the substance that makes up the M? How might these two substances be similar to or different from water?

A robust class discussion could elicit student thinking about what might explain the phenomena that we observed, and then the teacher can move toward sense-making by introducing the terms *solubility, polarity* and *density* as properties of matter that precisely name what has already been described during the discussion.

To then push students further to apply these new concepts, the procedure could be repeated in different liquids, such as isopropyl alcohol (also polar, but less so than water) and oil (non-polar) to observe how the rate of dissolving changes. A POE (predict-observe-explain) framework would be a nice way to approach this, pushing students to explain what they observe using one or more of the new physical properties. To explore density, try it with hot water; you’ll observe a quicker dissolving process (which can be explained by the added thermal energy), and then when the M detaches, watch it fall to the bottom of the cup rather than float to the top (because the water is now less dense at a higher temperature, so the static density of the M is now greater than the water surrounding it).