Welcome to NSTA’s Daily Do
Teachers and families across the country are facing a new reality of providing opportunities for students to do science through distance and home learning. The Daily Do is one of the ways NSTA is supporting teachers and families with this endeavor. Each weekday, NSTA will share a sensemaking task teachers and families can use to engage their students in authentic, relevant science learning. We encourage families to make time for family science learning (science is a social process!) and are dedicated to helping students and their families find balance between learning science and the day-to-day responsibilities they have to stay healthy and safe.

What is Sensemaking?
Sensemaking is actively trying to figure out how the world works (science) or how to design solutions to problems (engineering). Students do science and engineering through the science and engineering practices. Engaging in these practices necessitates students be part of a learning community to be able to share ideas, evaluate competing ideas, give and receive critique, and reach consensus. Whether this community of learners is made up of classmates or family members, students and adults build and refine science and engineering knowledge together.

Can water change the path of light?
Introduction

In today's task, *Can water change the path of light?*, students engage in the science and engineering practice of developing and using models and the crosscutting concepts of patterns and cause and effect to begin to make sense of the idea that light's otherwise straight path bends when it strikes surfaces between different transparent materials.

Flipping Arrow Phenomenon

Tell students you have a very weird phenomenon you’d like to show them. Ask them to create a space in their science notebook to record observations. You might ask them to label one page "Noticings" and a second page "Wonderings".

Share the Amazing Arrow Trick video with students (consider playing the video without sound). Working in the ALONE ZONE (independent thinking time), have students make and record their observations using words, pictures and symbols. Encourage them to also record questions that arise.

Ask students to share their observations with a partner or small group. Identify observations the group had in common and then an observation that only one or two group members recorded. Then, bring the groups back together and ask each group to share two common observations and one observation that only one or two group members noticed. Create a class record of these observations, you may want to circle those observations that only a few students noticed.

Ask students, “Based on our class observations, can you create a model to explain why the arrow flipped direction when water was added to the glass?” Give students Alone Zone time to complete their model. You might ask students, "What components (parts) need to be included in the model? and "How do these (point to two components) interact? How might you show this interaction?" to help them get started.

Next, give students an opportunity to compare their models with a partner or small group. They should note similarities and differences. Ask them to identify the components they all agree should be in a model explaining why the arrow flipped. Then, bring students back together.

On a poster or using an electronic document create a class consensus model. Ask each group to share one component that should be included in the model and then add that component to
model. As components are added to the model, ask the group sharing how that component might interact with one or more of the components already represented (it's OK if students can't identify an interaction). As you add each component/interaction, ask the class if they agree with the additions. If they do not agree or are unsure, ask if you can put a question mark on the model and come back to it later. You should have the students copy the consensus model in their science notebook so they can track what they figure out.

Ask students to review their initial questions, class observations and class consensus model and add any new questions they have about the phenomenon. Then ask them to choose one question to share with the class. You could ask students to post their questions on the class consensus model (place questions slightly off to the side so as not to cover the components/interactions represented). Which part of the model is their question about? The other students can help the student posting the question decide.

Students may ask:
- What happens if we look from the top, bottom, or sides?
- Does it only work with an arrow?
- What would happen if we pointed the arrow up? Would it point down when water is added?
- Is everything we look at through a glass of water reversed, and we just don’t notice it?
- Do all liquids do this?
- What is special about water?

Based on the questions students ask and the gaps on the class consensus model, you might say to students:
- “I hear a lot of you talking about how arrow flips, but it looks like we don’t agree on how we see the arrow before adding the water. Should we figure out how we actually see things to begin with?” OR
- “Back that up . . . how do we see the arrow in the first place? Should we figure that out first?”

**Investigation 1**

**Materials** (for the whole class)
- stuffed animal or other object
- flashlight

Have students sit and observe a stuffed animal or other object in the room. Turn off all the lights (it is actually better if the room is not completely dark). Ask students, "What do we need to be able to see the stuffed animal?" Students will likely identify light. Then ask them, "What would help us see the stuffed animal better right now?" Students will likely tell you they need more light. Shine a flashlight on the object and ask, "How is shining the flashlight on the stuffed animal helping you to see it better?" Ask them to turn to a partner and share their ideas. Then, ask students to work with their partner to create a model in their notebooks explaining how they are able to see the stuffed animal.
As you move around the room, you might ask students the following questions:

- In which direction is light traveling from here (point to component) to here (point to another component)?
- How could you use your model to explain why we could see the stuffed animal better in bright light than dim light?
- Is the light coming from the stuffed animal to the eye the same light you show coming from the flashlight? How could you show that on your model?

If students' models are missing components (light source, eye, object, unobstructed path), you might ask them, “What could you do/change to make the stuffed animal NOT visible?” Give students a minute or two to think and record their ideas. Then ask them to share their ideas with a partner. As you move around the room, listen for them to share ideas about closing their eyes, “blocking” the view, or turning out the lights. Also look for students who represent light rays as straight lines with arrows to show direction of movement. When you bring the class back together, call on those students first to share their ideas. Ask, "How might you represent these ideas on your models?" Then, give students time to revise their models.

Redirect students’ attention to the class consensus model. You might start the conversation by asking, “What should we add to or change on our class consensus model?” Ask for a student or group to volunteer what they think should be added to the model. Follow up with questions such as, “How should we represent that component/interaction on our model? Are we OK with that?” You can do the thumbs up, sideways, or thumbs down technique to gauge quick agreement. You may have to leave or add question marks on the class model.

After groups have shared their ideas, ask, “Who feels like their idea is not quite represented here?” Allow groups to share their ideas and support those ideas with evidence from their observations (data).

Ask students which questions they are now able to answer (it’s OK if none of the questions have been fully answered at this point). Invite them to add any new questions they have about the phenomenon.

When the class has reached consensus, ask, “Where should we go next to help us with areas where we are not sure?” Students will likely wonder how adding water affects the way they see the arrow.
Investigation 2

Materials (per student or student pair)
- Drinking glass or beaker
- Water
- Pencil or craft stick

Tell students to place the pencil in the water. Ask them to make and record observations. Students should notice the pencil looks split/broken in two and shifted when looking through the side of the glass. Encourage students to look at the pencil from all directions.

Ask students to explain why the pencil appears broken/bent using words, pictures and/or symbols. Refer students back to their partner models (explaining how we see the stuffed animal), the class consensus model and class list of observations to identify evidence that will support their explanation.

If students are representing light as lines, you might ask:
- Where is this light ray coming from? How could you show the light was coming from here (point to source) and hitting here (point to object)?
- What happens to the light when it hits here (point to object)? How could you show that?

If students are struggling to get started, you might ask:
- Let's look at this part of the pencil sticking out of the glass. How could you explain how we see this part of the pencil? (Look back to your partner model of the stuffed animal/our class consensus model.)
- What about the part of the pencil that is between the top of the water and the top of the glass? Is that like the stuffed animal? Or more like the flipping arrow? So how could you represent how we see it in your explanation?
- Look at the part of the pencil in the water. Do you think it's like seeing the stuffed animal or more like the flipping arrow? What part of the model (component/interaction) would you have to change/keep the same to explain how we see this part of the pencil?
- How is the pathways of light the same in all of these instances?
- How do you think the pathways are different?

Bring the students back together. Ask students, working in small groups to compare their bent pencil models to the class consensus model. You can ask them “Hold on . . . in what ways are these two examples the same?” or “What seems to be true in both of these phenomena?” Groups can share their ideas and support those ideas with evidence from their observations (data).

At this point in the task, the class consensus model should already include a light source, an eye,
the card with arrows and glass of water. Ask a student to come to up to the model and draw a line representing a ray of light shining from the source to the tip of the arrow. Ask a second student to take over at the model and show (with coaching from class) the light reflecting from the tip of the arrow, through the water and then to the eye. You might ask, "What is that line coming out of the arrow tip? (Light) Where is that light coming from? (Source). How could you show this is the same ray of light as this one? (Connect the lines/show the line bend). Ask a third students to show the light coming from the light source to the tail end of the arrow. Then, ask a fourth students to show the light coming from the tail end of the arrow through the water and to the eye.

Point to the model and ask, "Does this explain how we see the arrow reversed?" Follow the light ray from the tip of the arrow to the eye and then the light from the tail of the arrow to the eye and ask, "According to our model, is the arrow pointing in the same direction or is it flipped?" Students will likely realize they need to represent the light rays crossing to explain why the tip of the arrow 'ends up on the other side' and vice versa.

The goal of this task is for students to conceptually understand water changes the direction of the path of the light. It's OK if the location of the focal point (place where light rays would cross) is not correctly represented as long as it is beyond the location of where the light rays enter the water.

You might ask students to think about and share experiences where an object was distorted or seemed to disappear that might be explained by another medium causing the path of light to change.

**NSTA Collection of Resources for Today's Daily Do**
NSTA has created a Can water change the path of light? collection of resources to support teachers and families using this task. If you're an NSTA member, you can add this collection to your library by clicking Add to my library located near top of the page).

**Check Out Previous Daily Dos from NSTA**
The NSTA Daily Do is an open educational resource (OER) and can be used by educators and families providing students distance and home science learning. Access the entire collection of NSTA Daily Dos.