Oobleck (Walking on Oobleck)

Amount of time Demo takes: 2-5 minutes

Try this at home!

Lesson's Big Idea

- Non-Newtonian fluids are liquids whose viscosities change depending on pressure. When force is applied, the oobleck's cornstarch (solid) molecules are pushed closer together, causing the liquid to act like a solid!

Materials

- Cornstarch in 50 lb bags (6)
- Water (30 gallons)
- Cement mixer (1) - **Needs electricity**
- Wood frame and parts (4 parts) - Bolts can be found in the toolbox
- 3 mil, 20 x 40 painters in tarp, folded in half
- Bleach (2 cups)
- Putty knives and scrapers
- Rubber mats (14)
- Foot washing tub & chairs to take shoes on/off
- Hefty trash bags (20)
- Paper towel (10 rolls/half day)

SAFETY!

- **NEVER PUT OOBLECK DOWN THE DRAIN!** When water is used to wash it down the drain, the oobleck will thicken under the force and cause a massive clog.
- Use 2 cups of bleach for 30 gallons of water. This is a lot of bleach, don't use more!
- If there are people running across the oobleck, ensure that the area is clear. Only allow one person at a time to prevent collisions. Keep excess water off the floor to prevent slipping.
- Mind Trekkers should stand on each side of the frame to help volunteers

across if needed.

- This demonstration requires a firm hand. Do not let students get too crazy on the oobleck to reduce the risk of slipping. Students should have quick feet to stay on top of the oobleck, but they shouldn't be sprinting across it (think football steps).
- Volunteers should not let students sink down into the oobleck unless they are near, as many students jerk their feet causing them to fall when the oobleck doesn't let them go.

Background Information

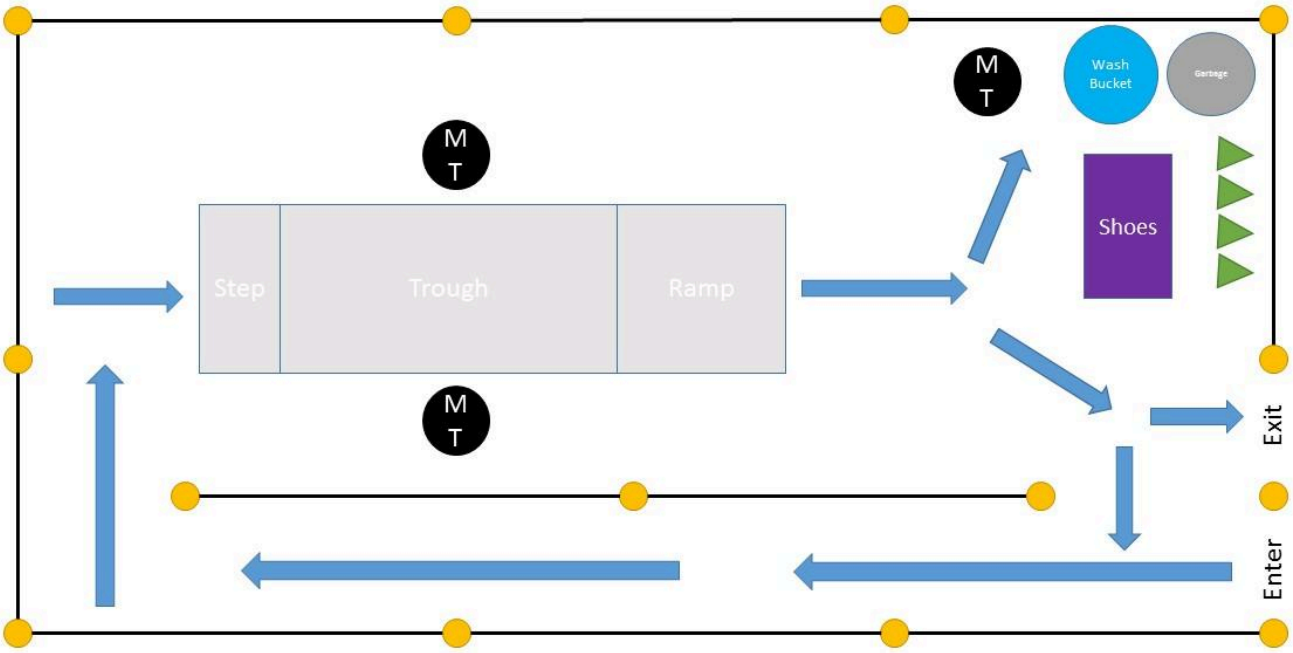
- Most fluids are what is called a Newtonian fluid. Newtonian fluids are incompressible and therefore have a single measurable viscosity. Water is an incompressible Newtonian fluid. This principle is why hydraulics work. If you apply force to water, the water transfers the force instead of compressing. However with things like foam, the material compresses under pressure, allowing the force to disperse throughout the material. This is why it still hurts to hit water (think of a belly flop), but not fall onto a foam mat.
- Non-Newtonian fluids are compressible. This means that they don't have a single measurable viscosity -- rather, the viscosity is actually a function of force applied and time. When force is applied, the fluid compresses, getting more viscous, meaning that it does not flow as easily. This works because oobleck is not actually a solution, but a **suspension**. The corn starch does not dissolve in water -- rather, it is suspended in the water. When you apply force to oobleck, the water (which is incompressible) simply moves out of the way, and the cornstarch molecules get closer together. The closer the cornstarch, the more solid the liquid will feel. It is important to remember that oobleck is **always a liquid**; it is simply a *very* viscous liquid.

Setup Instructions

1. Create the wooden frame. Ours is approximately 2' by 5' on the inside. The sides can be made by putting 2x4 boards between 1x4 boards. Make sure all the boards are secured. Place the plastic sheeting over the boards, so that some hangs over each side. Wrap the excess painters tarp underneath the trough so the weight of the oobleck keeps it in place.
2. Secure the step platform to the front (side students will start on) of the trough using the bolts (poke through the painter's tarp). The ramp

attaches to the end the students exit the trough.

3. Lay out the rubber mats. When indoors, painters tarp should be placed beneath the mats for easier clean up. Lay the 4 x 6 anti-slip mats 3 across, and 4 down. Place the trough on the mats so the students run lengthwise down the anti-slip mats. Place the two cashier's mats at the end of the trough under the anti-slip mats so you can scrape them from time to time back into the trough.
4. For mixing, a cement mixer can be used.
5. Periodically dump your oobleck into the tub. If you make a runny batch, make a slightly thicker batch to balance it out. Keep adding until you have enough oobleck to run over. Our tub takes about 300 pounds of cornstarch and 30 gallons of water to fill. Lastly, add about 16 oz of bleach to keep away bacteria and nasty smells.
    a. A properly made oobleck batch fills the trough about ¾ of the way high, and when you swipe your hand across the surface, there is no water that sprays. Also, when you hit the oobleck, there is no splatter and it resists your hand.
6. Set out chairs for students to sit on while taking off/putting on their shoes. Set out carpets around area so people don't slip on concrete floors or track cornstarch all over the venue. Set out a tub to wash feet off in. Periodically clean oobleck off of rugs and floor areas to keep it from getting slippery on the floor.
7. Tear paper towel ahead of time and set aside.
8. **Plan on an hour of clean up time.**
9. Example set up layout *(not all stanchions may be needed based on walls)*:



Instructional Procedure

1. Ask participants to remove shoes and socks and roll pants up to the knee.
2. Have one person at a time start at the end of the trough of oobleck. For young or nervous participants, you can help them step up onto the ledge of the trough, holding their hand until they are ready to go. Enthusiastically explain how they should run with quick feet. If they slow down or stop their feet will sink in like quicksand.
    a. Think "football feet". Imagine football players doing their quick feet drills.
3. Spot them from the side as they run, making sure they don't fall and can get out at the end. Encourage them and be excited as they are going. Direct them to the area to rinse their feet off.
    a. If the students are purposefully going slow, getting stuck, or kicking Oobleck out of the trough, cut them off. This demonstration will be extremely busy so they shouldn't be slowing it down for everyone else and causing a mess.
4. Continually demonstrate running through oobleck to attract people and show how it is done!
5. Have the students get back in line if they want to go again or send them to wash their feet. Keep an eye on paper towel stock, change the garbage when necessary, and refill the wash tub with water when it gets dirty.
6. This demonstration requires a lot of crowd control. You can be fun and kind with still keeping control of the crowd. You need to manage those doing the demonstration for their own safety.

Tips & Tricks

- Typically you have 3 people working this demonstration (2 Mind Trekkers and a Volunteer), USE THEM! Put a Mind Trekker at the start and a Mind Trekker and Volunteer along the sides of the trough. Feel free to rotate.
- The person at the start needs to keep control and explain the rules.
- Oobleck takes a while to set up, so get started right away!
- You can color Oobleck (somewhat) with concentrated food gel. Just remember though you are mixing your colors with white so they will turn out much lighter than the gel color you pick out. Also, it will stain the volunteers skin as the day goes on.

Assessment Questions

1. What happened when you ran across the oobleck?
    a. You didn't sink because you are applying a force, causing the oobleck to act like a solid and support you.
2. If you slowed down or stopped what happened?
    a. You sink because you stop applying a force to the oobleck and it acted like a liquid, causing you to sink in.
3. What happens if you sink in the oobleck and then try to get out?
    a. If you jerk your foot up, you are going to apply a force in an upward direction and then the Oobleck will become a solid once again.

Careers & Real-World Applications

- Non-Newtonian fluids are found all around us! From paint to body braces and supports, these items are things that we don't even think about. Many body braces are made of a non-newtonian fluid that will move with your body, but in the event of impact, it becomes solid and prevents injury.
- **Careers:**
    - Painter
    - Civil Engineer
        - Concrete is an example of a non-newtonian fluid
    - Materials Engineer
    - Biomedical engineer
        - Body braces and orthotics

Clean Up

- Oobleck **cannot** go down the drain!
- Gather empty 5-gallon buckets and place heavy duty trash bags in them (making them effectively little garbage cans). Scoop the oobleck out of the trough with your hands and dump it into the 5 gallon buckets. Once the buckets are about ¾ full, they should be tied off. They will be very heavy and much more oobleck will cause them to rip.
    - Watch out how you set the full garbage bags down. If they tip over, oobleck might spill out of the bag by the tie. Remember It's a liquid when it's at rest!
- Scrapers and squeegees are helpful to get it up off the floor and other surfaces.

- Find a janitor's trolley or garbage wheelbarrow to haul oobleck out to dumpster.
- Hose off and wash the other items (cement mixer, buckets, mats, scrapers, trough, stanchions, chairs, etc.) that get covered in oobleck to the best of your abilities.
- Teamwork makes the dream work. Grab a lot of friends to speed up the process. Proper Oobleck clean up usually takes 45 minutes or so. You may need to shut it down early depending on your timeline.

References

- http://en.wikipedia.org/wiki/Oobleck
- http://aliciac.hubpages.com/hub/An-Oobleck-Recipe-and-Fun-Experiments-With-a-Non-Newtonian-Fluid

Related Next Generation Science Standards

- K-5
    - K-PS2 Motion and Stability: Forces and Interactions
    - 2-PS1 Matter and Its Interactions
    - 5-PS1 Matter and Its Interactions
- 6-8
    - MS-PS1 Matter and Its Interactions
    - MS-ETS1 Engineering Design